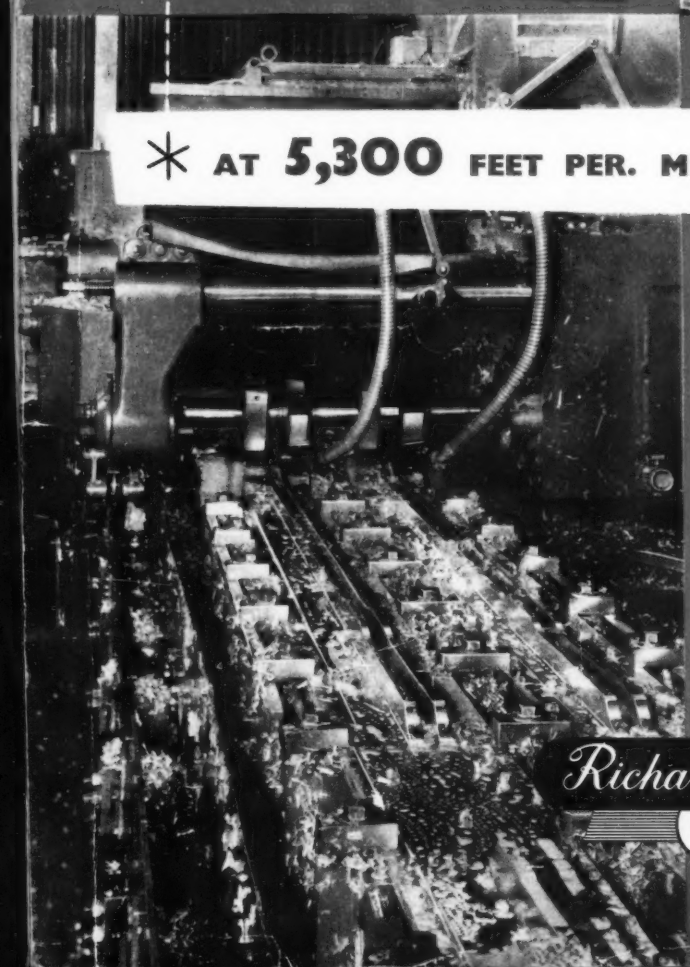
MACHINERY

JULY 16, 1958 ONE SHILLING & THREEPENCE

MILLING AIRCRAFT SPAR BOOMS



✳ AT 5,300 FEET PER. MIN.

Galtona O-K SERRATED BLADE CUTTERS

SUPREME FOR HIGH SPEED OPERATING

GALTONA O.K. special two-bladed carbide tipped cutters are illustrated machining light alloy aircraft main spars from the solid at a cutting speed of 5,300 ft. per minute. Four cutters operate simultaneously and metal removed by each cutter is 1¾in. by 1¼in. at a feed of 12in. per minute.

GALTONA O.K. standard and special cutters are available in all types for machining a wide variety of materials, and our Tool Engineers will always be pleased to make recommendations on request for cutters to suit individual needs, without obligation.

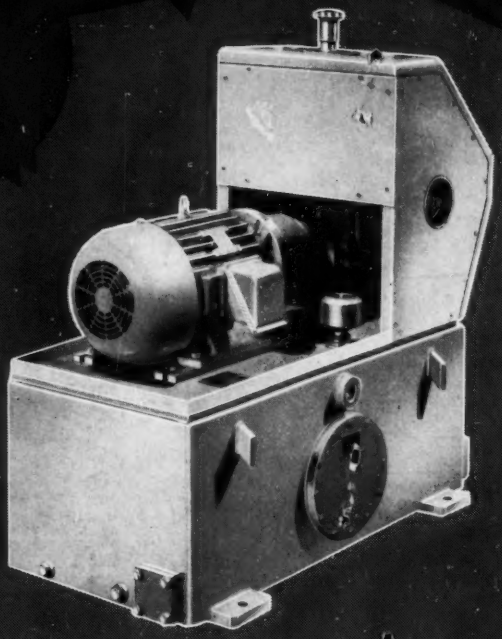
Richard Lloyd Limited

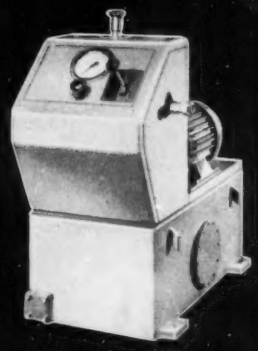
GALTON HOUSE, ELMFIELD AVENUE, TYBURN, BIRMINGHAM, 24

Telephone: Ashfield 1801. Telegrams "Cogs, Birmingham"

NORTHERN AREA OFFICE: A. V. Green, Britannia House, Wellington Street, Leeds, 1. Phone: Leeds 21212. LONDON AREA OFFICE: A. J. Percy, 240 Romford Road, Forest Gate, London, E.7. Phone: MAYland 7304-5. NORTHERN IRELAND: Garage & Engineering Supplies Ltd., 78 Great Victoria Street, Belfast. SCOTLAND: Stuart & Houston, 5, York Street, Glasgow, C.2.

off the peg but tailor made





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REGD TRADE MARK

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RODLEY NR. LEEDS ENGLAND
Tel: Pudsey 3125/6/7/8 Grams: Electrolic Rodley

Wickman

Econotip

The carbide tool you never re-grind!

Saves Reservicing Time and Equipment

No grinding ; when all the edges have been used, simply discard the tip and fit a new one.

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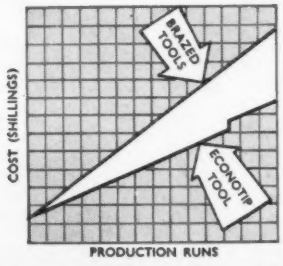
Leave the tool at its proper setting ; just change or re-locate the tip and save re-setting time.

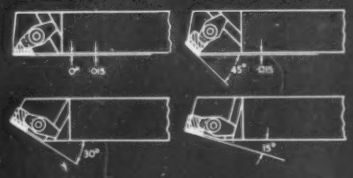
Improves Tool Performance

Stress-free Econotips give better tool performance, longer tool life and greater reliability.

Saves over 30% of tool costs



Graph shows savings secured by Wickman Econotip tools



4 Styles.... Four styles are available, with square tips to provide approach angles of 15°, 30° and 45°, and with triangular tips providing a zero approach angle.

....and 2 Wimet grades

Grade N for machining cast iron and non-ferrous materials, and grade XL 3 for machining steels at high speeds.

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Publicity Dept.,
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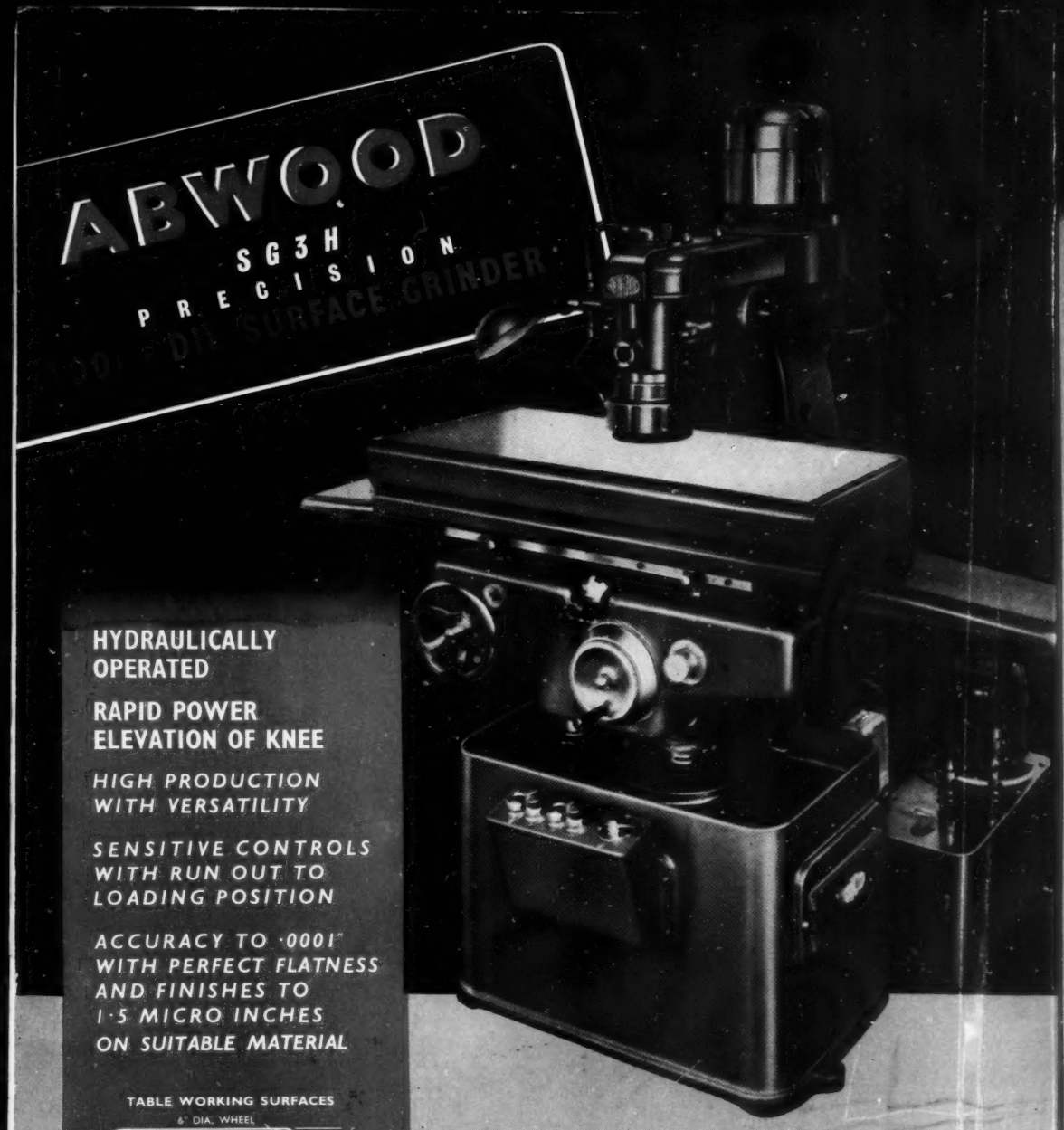
WICKMAN LIMITED

WIMET DIVISION, TORRINGTON AVENUE, COVENTRY

Telephone : Tile Hill 66621

S15 ST



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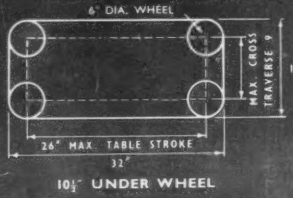
RAPID POWER ELEVATION OF KNEE

HIGH PRODUCTION WITH VERSATILITY

SENSITIVE CONTROLS WITH RUN OUT TO LOADING POSITION

ACCURACY TO ·0001" WITH PERFECT FLATNESS AND FINISHES TO 1·5 MICRO INCHES ON SUITABLE MATERIAL

TABLE WORKING SURFACES



This latest development model SG3H is "the" Machine for rapid Surfacing in the Toolroom or Production Shop. Detachable Spindles are available for deep and intricate work.

Hydraulic Control allows the operator to "inch" the Table along or stop instantaneously in any position at will.

Auto Run-out of Table to loading position.

Built in Coolant system with separation unit in Base.

Uses 6" Diameter Cylinder Wheels for faster Surfacing and Maximum wheel economy.

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Telephone : Dartford 5271 (5 lines)

Telegrams : ABWOOD DARTFORD

SG-1

Machinery
July 16, 195

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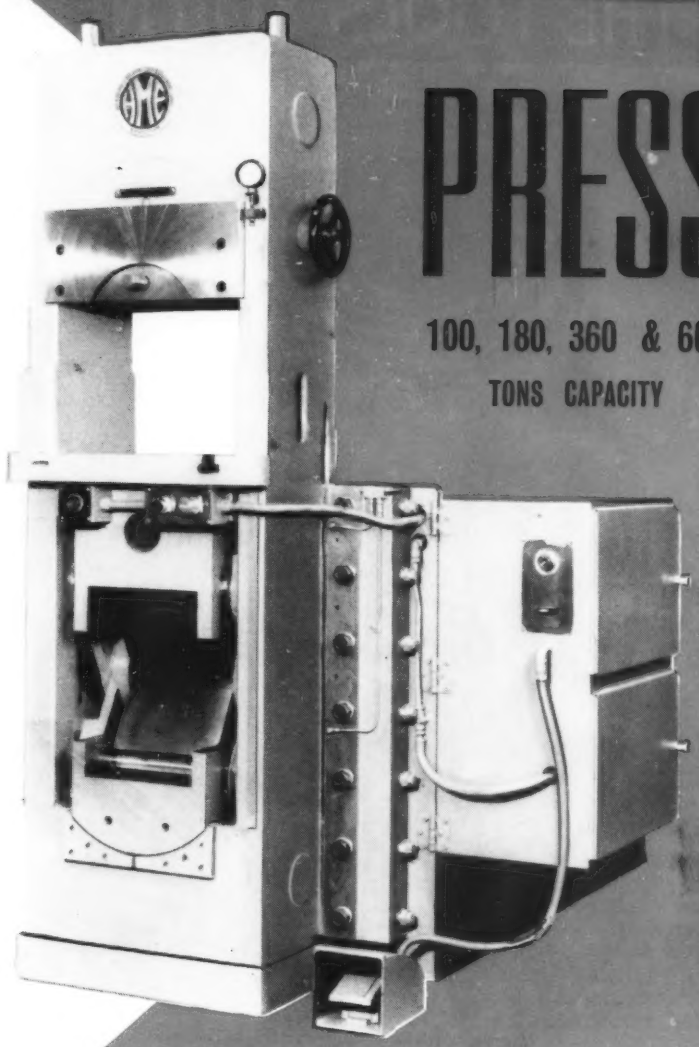
KNUCKLE PRESS

100, 180, 360 & 600 TONS CAPACITY

- A coining press of unusual design in which all tensile loads lie within a rectangular steel frame which moves in specially long slideways.
- Pressure being exerted is registered on a dial gauge; operator can check pressure being exerted at each stroke.
- Precise tool adjustment.
- Simple but very rigid construction.
- All moving parts totally enclosed.
- Circulating lubrication system.
- Control is by push buttons through a very efficient air operated friction clutch.



The front guard has been removed to show the toggle action of the press

Send now for Catalogue No. 17, or ask our technical representative to call.

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TELEPHONE: ASHfield 1671 TELEGRAMS: AITCHEMMEE, B'HAM

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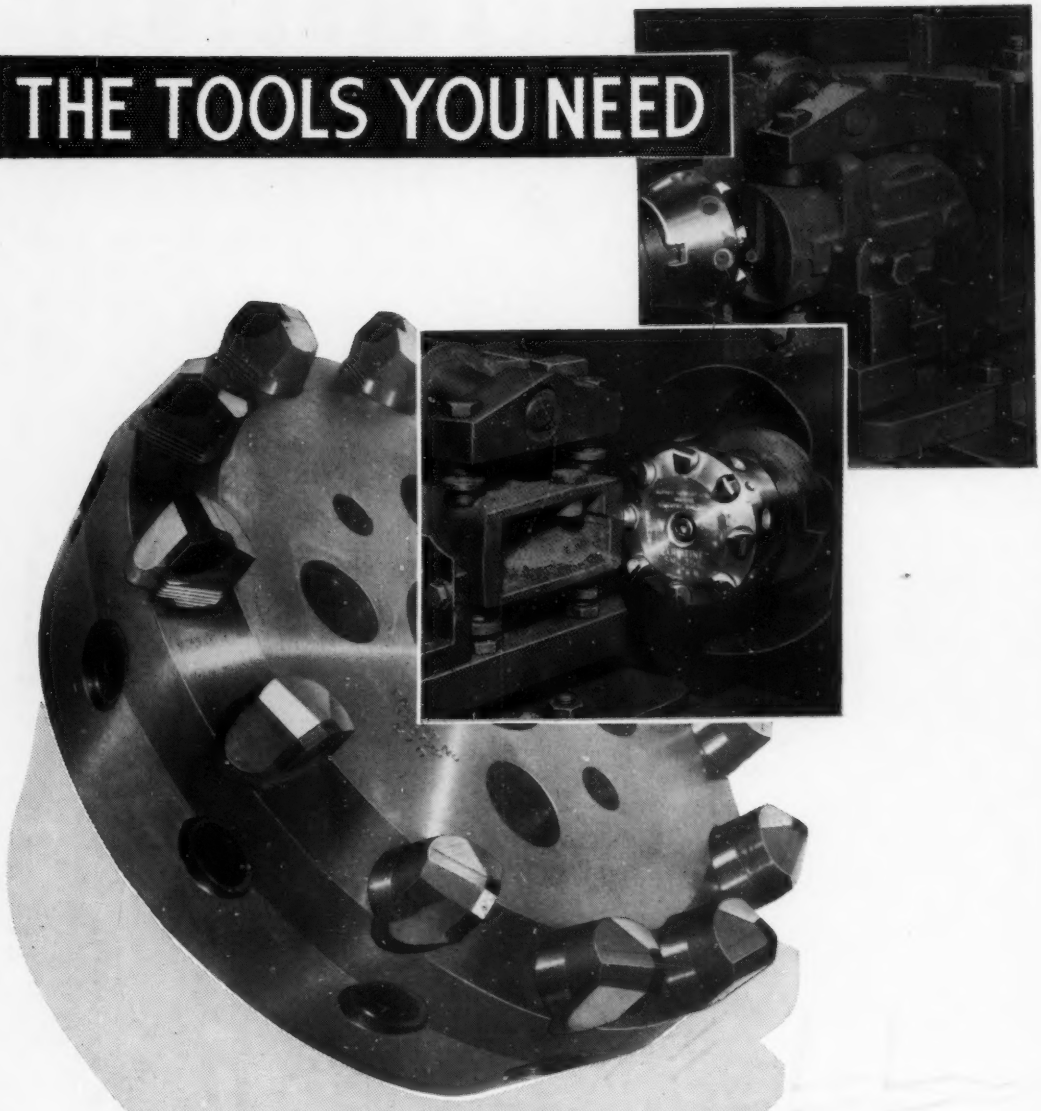

Inserted-tooth face milling cutters designed for specific operations on various materials.
Provide for milling operations on low, medium and high-powered machines.
Give high production with improved finish.
Cutters, high-speed or Ardoloy-tipped, with relative grade of carbide and/or cutting angles for various materials, are interchangeable on the general-purpose High-power Carbiface illustrated.
Cutters from 3in. to 16in. diameter with 5 to 20 blades available.
Patent tooth locking arrangement.

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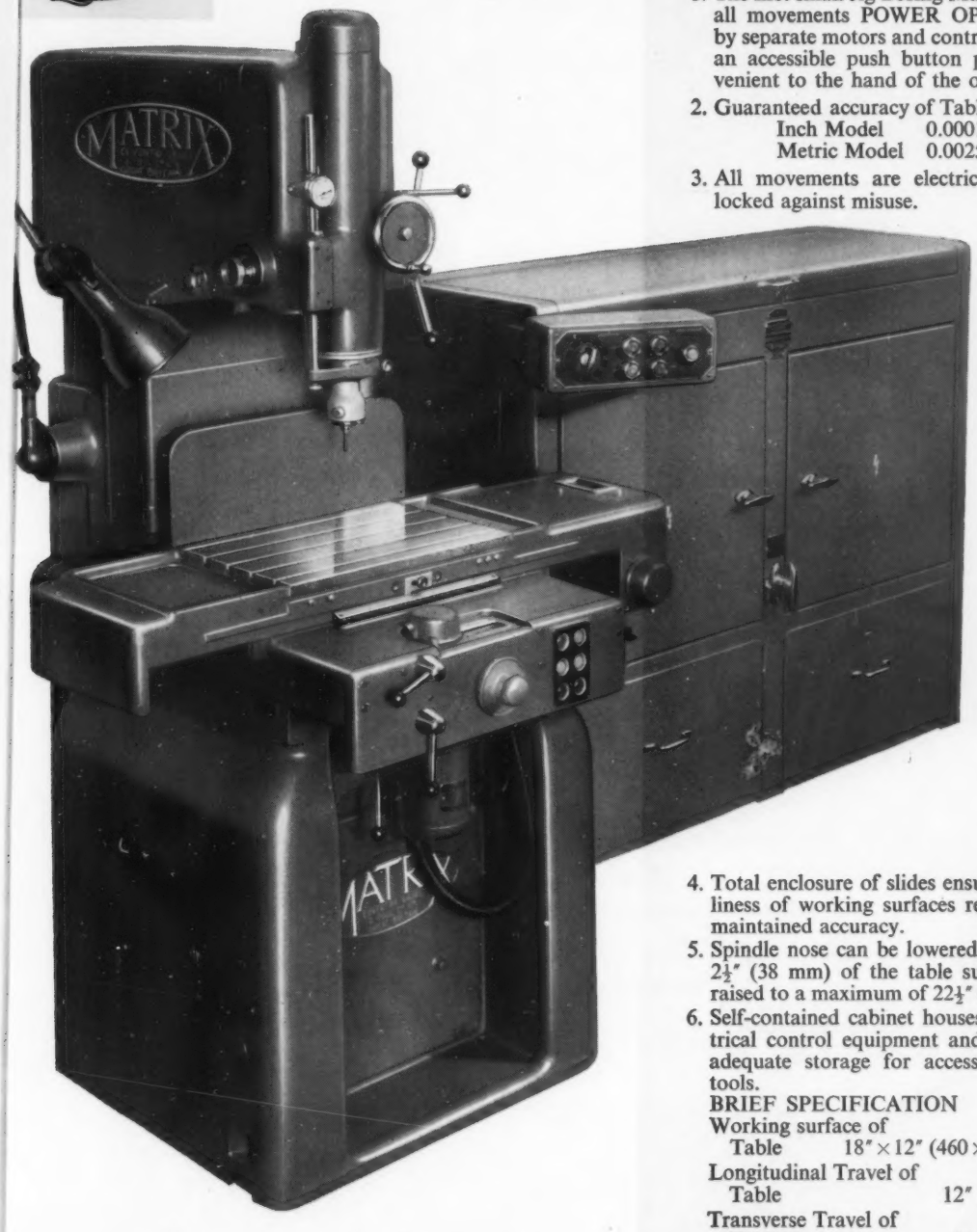
1. The first small Jig Boring Machine with all movements POWER OPERATED by separate motors and controlled from an accessible push button panel convenient to the hand of the operator.
2. Guaranteed accuracy of Table Settings:
   Inch Model 0.0001″
   Metric Model 0.0025 m/m.
3. All movements are electrically interlocked against misuse.



4. Total enclosure of slides ensures cleanliness of working surfaces resulting in maintained accuracy.
5. Spindle nose can be lowered to within 2½″ (38 mm) of the table surface and raised to a maximum of 22½″ (560 mm).
6. Self-contained cabinet houses the electrical control equipment and provides adequate storage for accessories and tools.

BRIEF SPECIFICATION

Working surface of Table	18″ × 12″ (460 × 300 mm)
Longitudinal Travel of Table	12″ (300 mm)
Transverse Travel of Table	8″ (200 mm)
Spindle Speed (stepless)	100-3000 r.p.m.
Max. Travel of Quill	4″ (100 mm)
Vertical Travel of Spindle Head	16″ (405 mm)
Max. Drilling Capacity in Steel	½″ (13 mm)
Max. Boring Capacity	3½″ (40 mm)

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- Available from stock in a range of from 2" up to 4¼" pitch.
- Built like a precision chain to withstand continuous heavy duty.
- Resistant to twisting or kinking.
- Guaranteed breaking load of 6,000 lb.
- Additional to our extensive 3,000 lb. range.
- Eliminate the need for heavier type chains and chain wheels, thus reducing overall weight in unit construction of conveyor systems.
- ATTACHMENT PLATES. Supplied with standard K and F type or with several other specialised forms of attachment plates.
- **Conform to British Standards** dimensionally, and may be used in conjunction with existing chain wheels and pinions in our extensive 3,000 lb. breaking load range.

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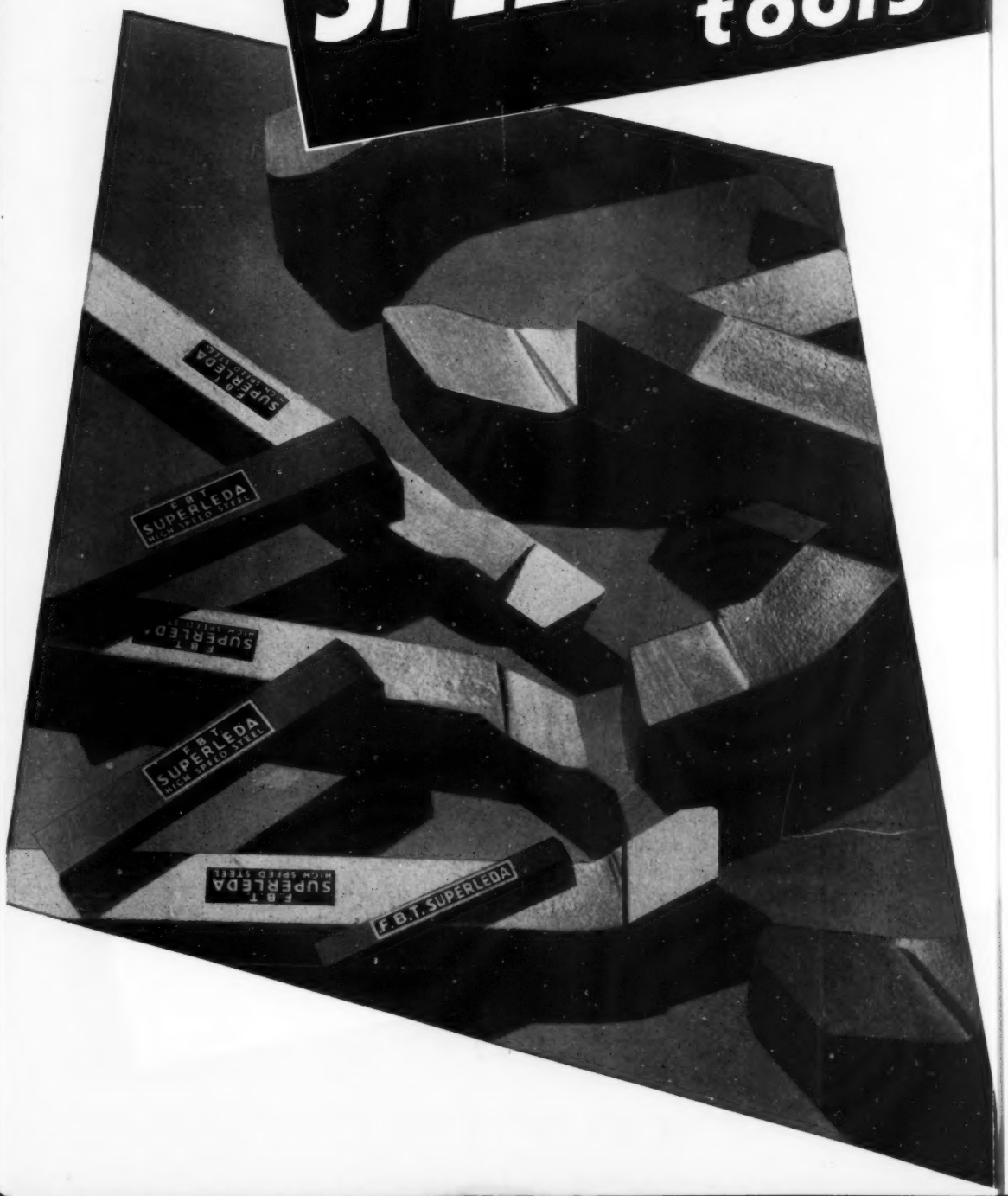
Chain and Chain Drive for every industrial application

PERRY CHAIN COMPANY LTD., TYSELEY, BIRMINGHAM 11 *(A Division of the Perry Group)*

PI/25

From the range of SPEEDICUT tools


F.B.T. SUPERLEDA HIGH SPEED STEEL
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SPEEDICUT SUPERLEDA

Butt Welded Lathe Tools and Toolholder Bits

Speedicut Superleda Butt Welded Tools and Toolholder Bits are specially heat treated to give the combination of 'red hardness' and toughness needed for heavy duty working.

Planing, shaping and heavy intermittent cuts are the problem; SPEEDICUT SUPERLEDA is the answer.

Take advantage of the latest techniques in toolmaking— SPECIFY SPEEDICUT.

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SPEEDICUT WORKS, CARLISLE STREET EAST, SHEFFIELD

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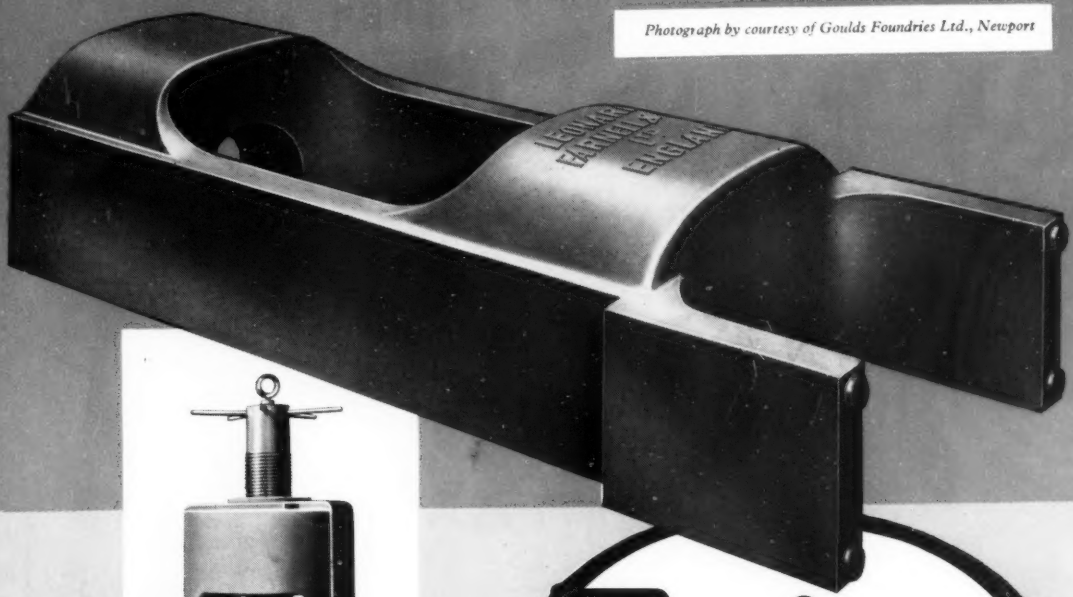

Tough Assignment

– but not too tough for

MEEHANITE

One of the tests for concrete involves the application of a compressive load to a test specimen until failure occurs. This load may exceed 10,000 lbs./sq. in.

The machine illustrated is a 200-ton hydraulic press designed and made by Leonard Farnell & Co. Ltd. to carry out this test to B.S.S. requirements. The main load frame, incorporating the hydraulic cylinder, is a single casting of GA Meehanite, chosen for its high strength, absolute soundness and ease of machining. Homogeneity is vitally important, since the hydraulic working pressure may reach 6,000 lbs./sq. in and it is impossible to test for porosity until the casting has been machined.

Write for a copy of "Meehanite in the Service of Industry", a 44-page illustrated booklet describing the varied applications of Meehanite throughout industry.

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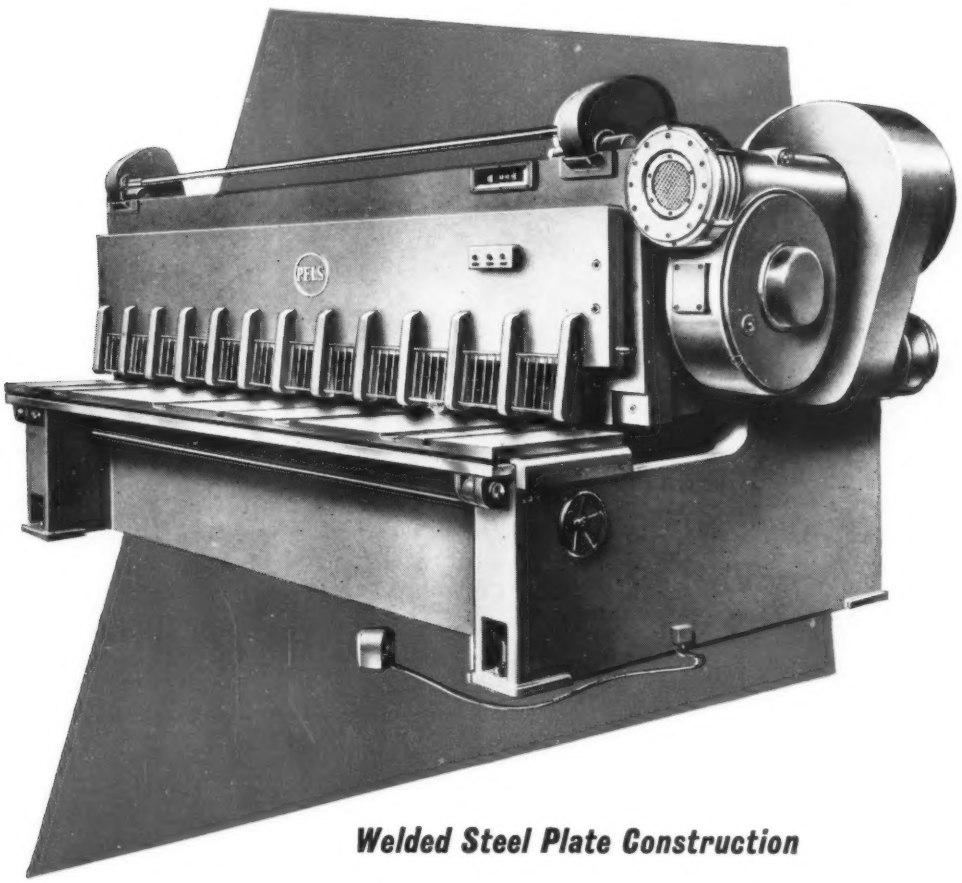

Welded Steel Plate Construction

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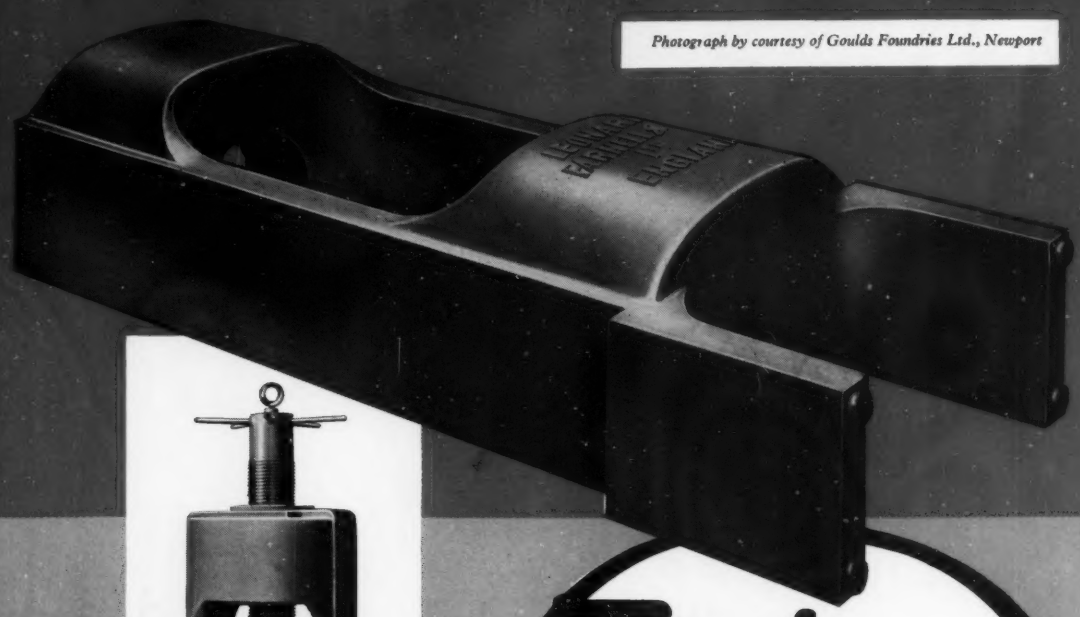
Offices & Showroom 32-38 OSNABURGH STREET · LONDON · N.W.1

Telephone EUSTON 4113

Rainbow 1301

Photograph by courtesy of Goulds Foundries Ltd., Newport



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Cast Iron Can Do it-if it's

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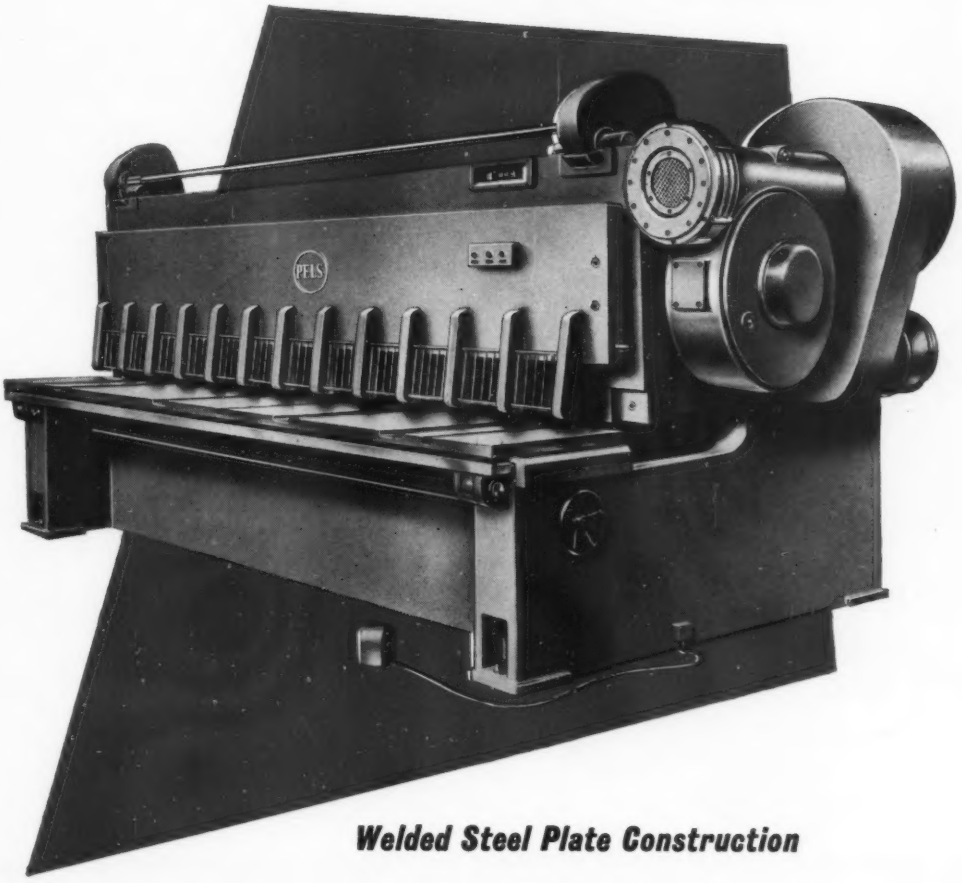
⅛" TO 1" CAPACITIES

FOR PRECISION SHEARING TO EXCEPTIONAL STANDARDS



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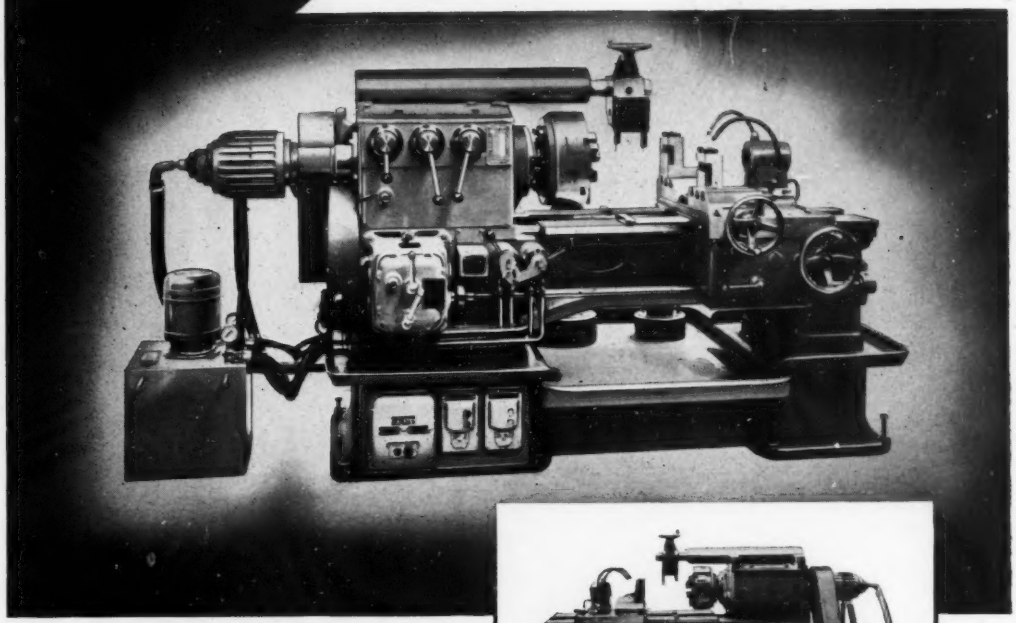
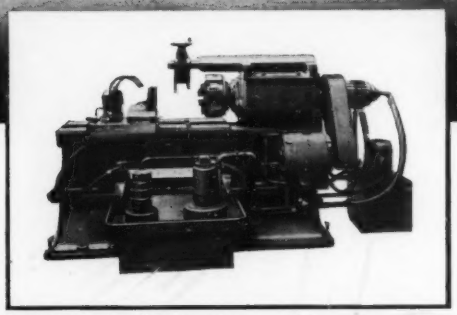
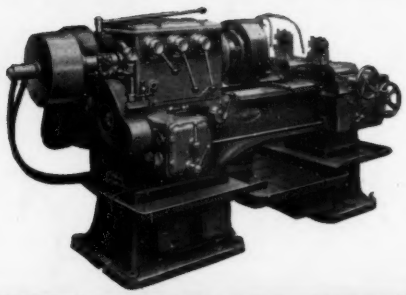
CROWTHORN

8½" CENTRE PARTING-OFF TURNING & BORING LATHE







This lathe is specially designed for the high speed production of such articles as cylinder liners, piston-rings, etc., and for the rapid parting-off of ferrous and non-ferrous bar and tube. The specification includes pneumatic or hydraulic chucking equipment, screw operated parting-off toolslide assembly on overhead arm, front and rear tool holders, boring bar holders, self contained motor drive and electric suds pump. Please write for detailed literature.

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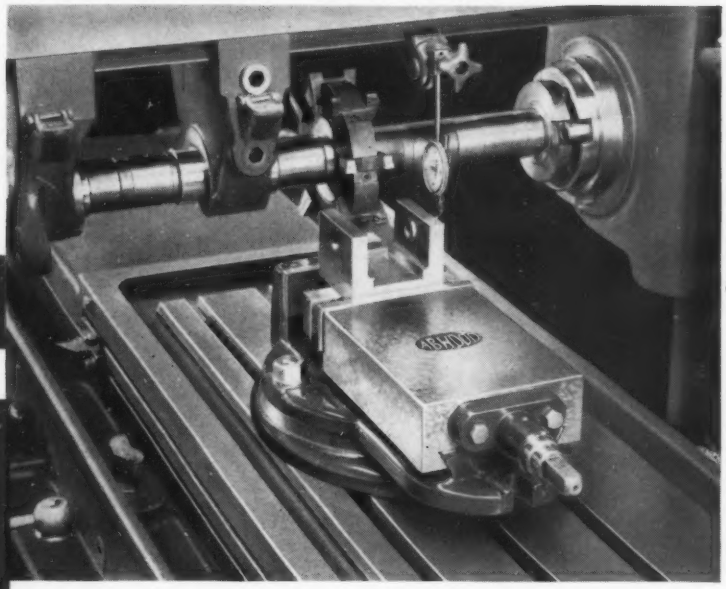
ABWOOD *For Accuracy plus Durability*

THE ABWOOD MODERN MACHINE VICE

NO TRAPS FOR SWARF
TOTAL ENCLOSURE OF SCREW & NUT

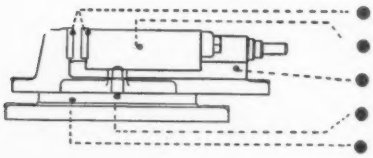
THE VICE WITH THE SLIDING JAW WHICH CANNOT LIFT AND TILT THE JOB



Clocking set-up of Drill Jig before milling faces for insertion of hardened location strips. This work-holding problem was resolved by the use of an Abwood Machine Vice thus ensuring complete absence of any lift.

FULL RANGE OF SIZES AND TYPES FROM 3" to 15"

VISUALISE WHAT AN IMMENSE SAVING THIS MEANS



- **PRECISION GROUND CARBON STEEL JAWS**
- **SLIDING JAW MACHINED OVER THE WHOLE OF ITS SURFACE FOR USE OF SCRIBING BLOCK**
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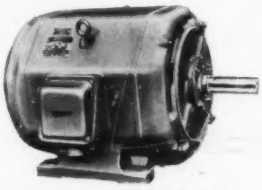
Newman IN STEP WITH PROGRESS



DOUBLE AIR CIRCUIT MOTOR

DOUBLE COOLING

One of the most important aspects of totally enclosed motors is the method of cooling—upon this depends, to a large extent the efficiency, reliability, size for rated horse-power and ultimately the final cost of the motors. Newman have recently introduced a range from 25 to 150 h.p. with a unique double ventilation system which almost doubles the cooling efficiency of these motors and results in more economical and more compact construction.

YET ANOTHER EXAMPLE OF THE NEWMAN PROGRESSIVE DESIGN POLICY

Newman

making the pace in motor progress

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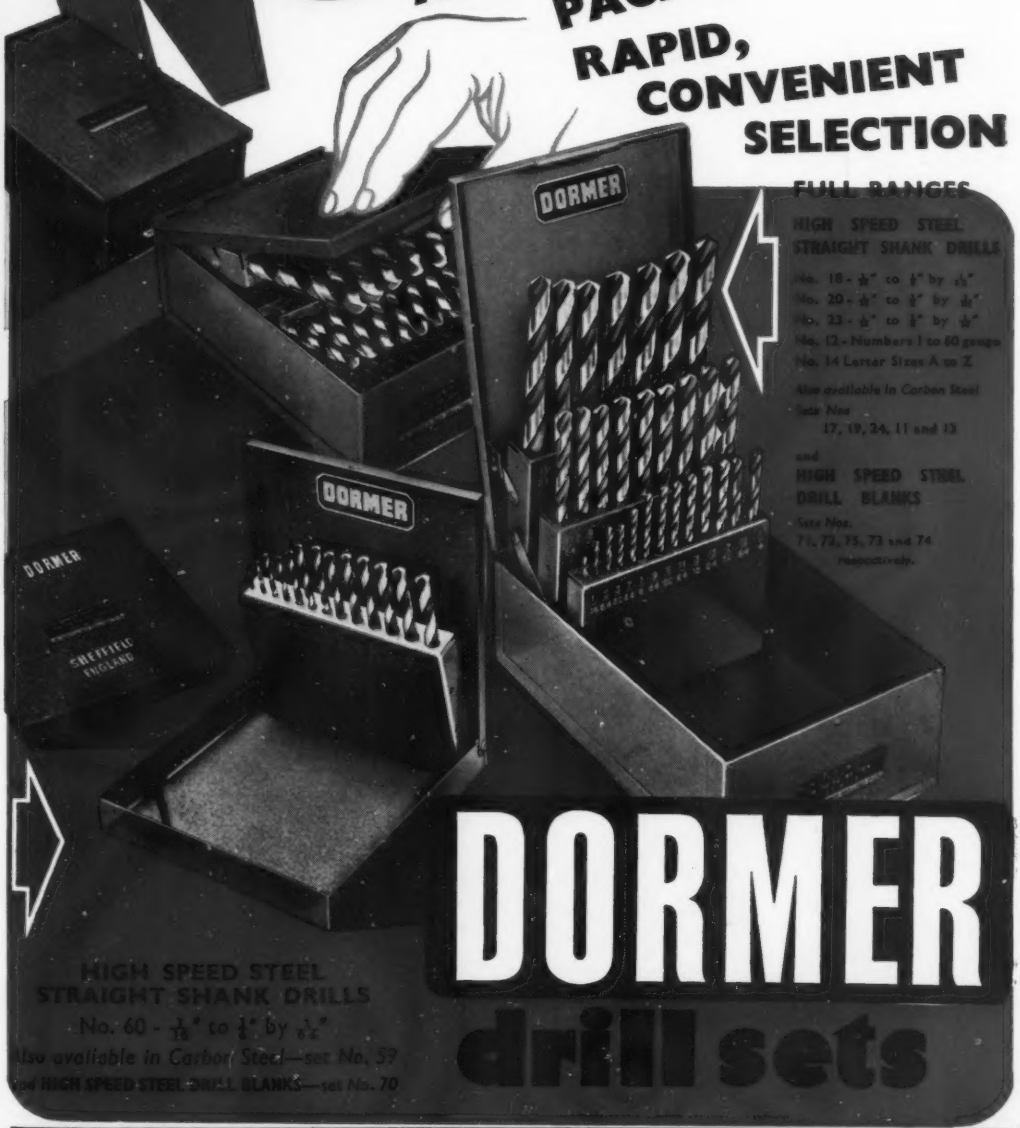
ALL STEEL RETRACTABLE PACKAGING FOR RAPID, CONVENIENT SELECTION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DORMER
DORMER
SHEFFIELD ENGLAND
FULL RANGES
HIGH SPEED STEEL STRAIGHT SHANK DRILLS
No. 18 - 1/32" to 1/4" by 1/64"
No. 20 - 1/32" to 1/2" by 1/64"
No. 23 - 1/32" to 1/2" by 1/32"
No. 12 - Numbers 1 to 60 gauge
No. 14 Letter Sizes A to Z
Also available in Carbon Steel
Sets Nos. 17, 19, 24, 11 and 13
and
HIGH SPEED STEEL DRILL BLANKS
Sets Nos. 71, 72, 75, 73 and 74 respectively.
HIGH SPEED STEEL STRAIGHT SHANK DRILLS
No. 60 - 1/32" to 1/4" by 1/64"
Also available in Carbon Steel—set No. 59
and HIGH SPEED STEEL DRILL BLANKS—set No. 70

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drill sets

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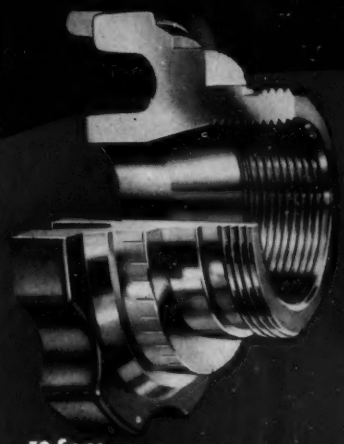

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Threaded Component
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Graduations rolled on
Threads chased

87 Secs.
Locking Ring
(Hot Brass Pressing)
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220 Secs.
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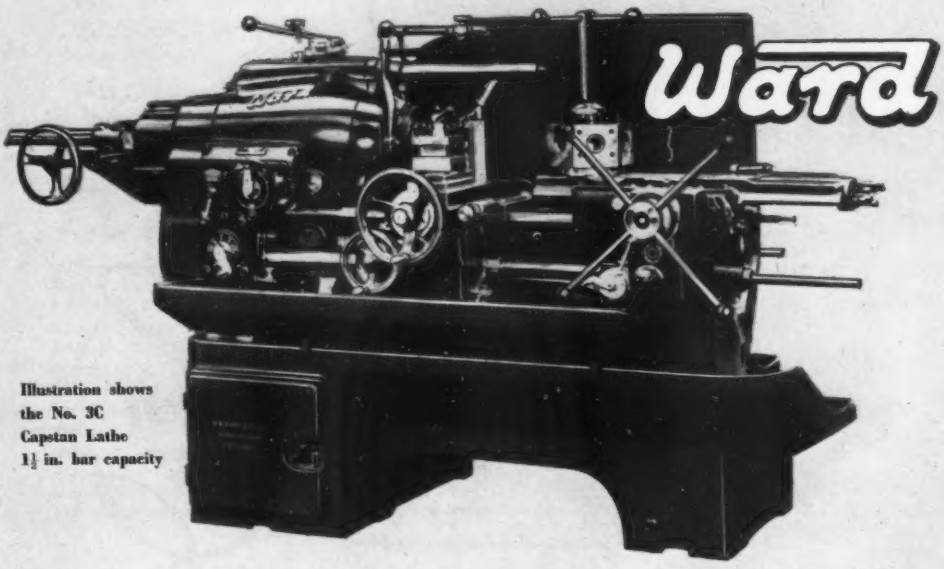

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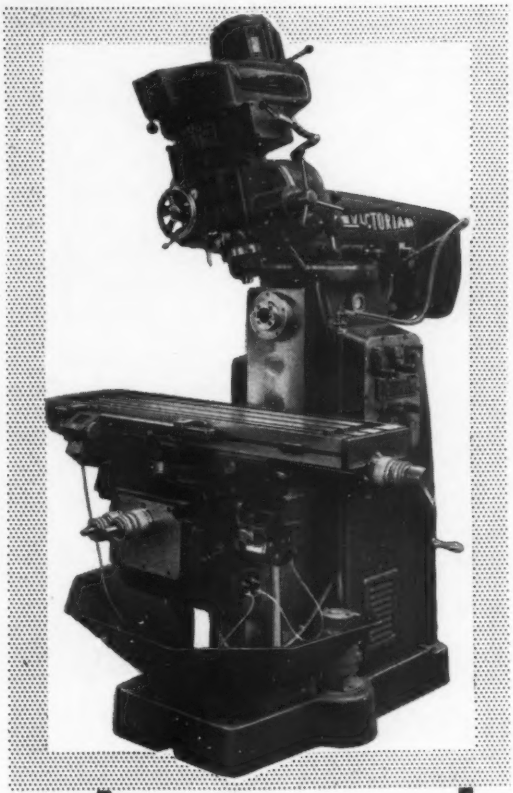

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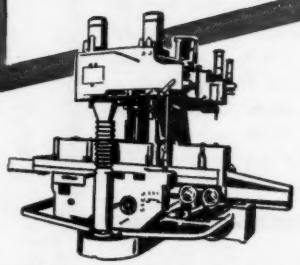

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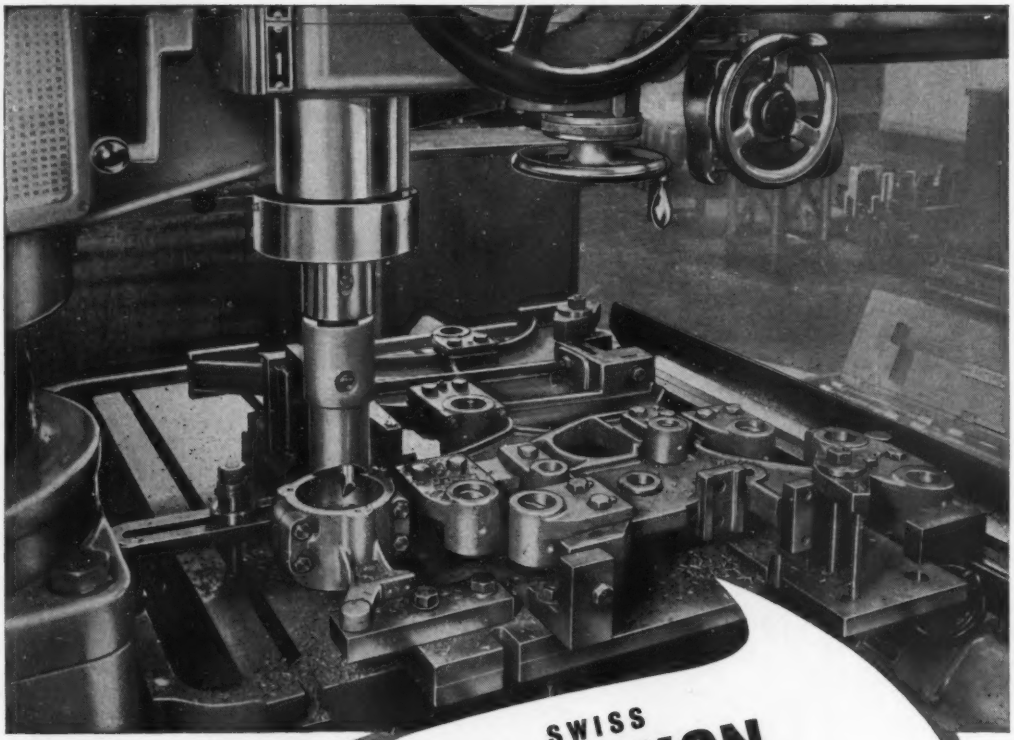

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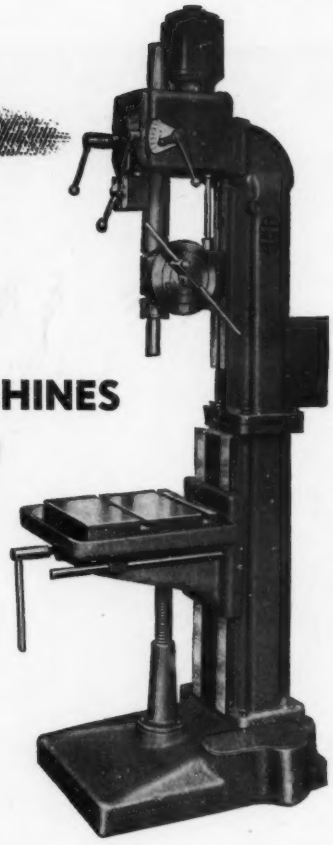

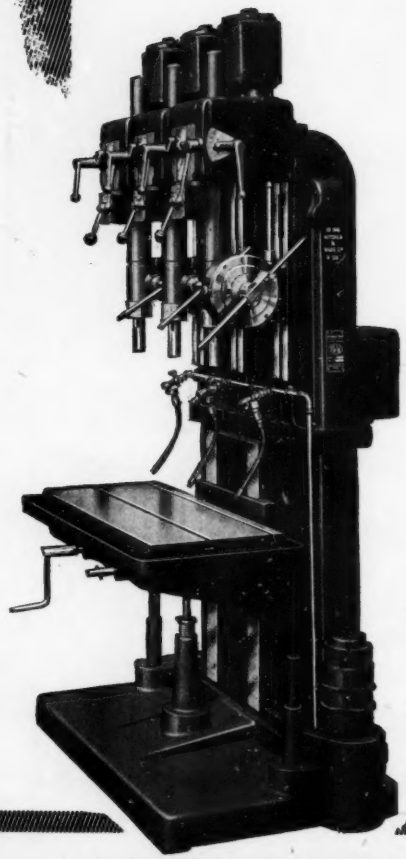

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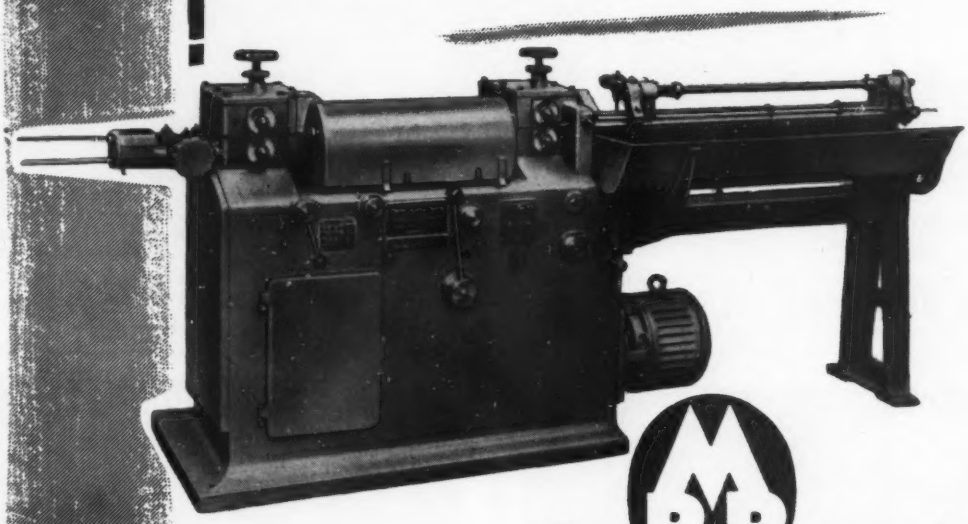

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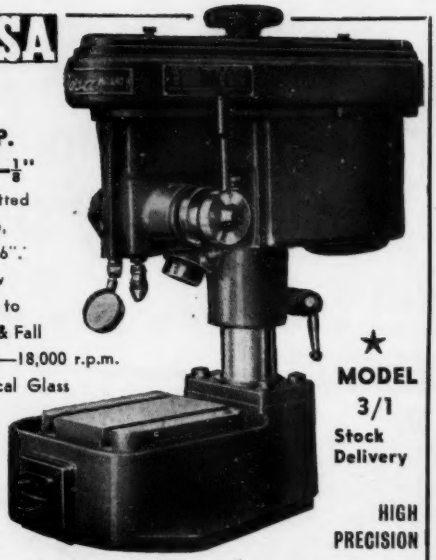

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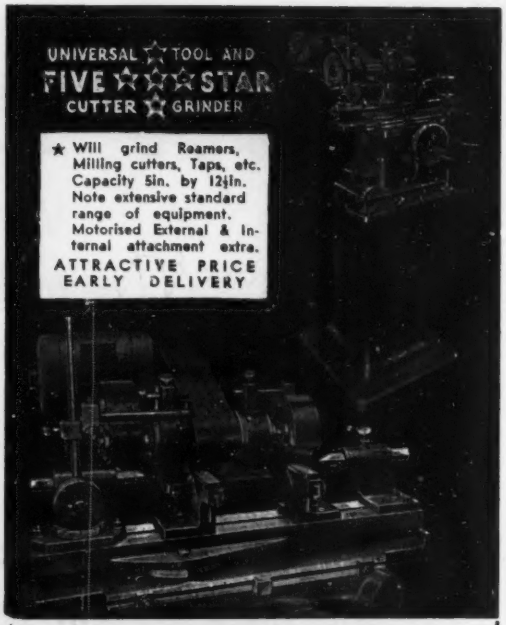

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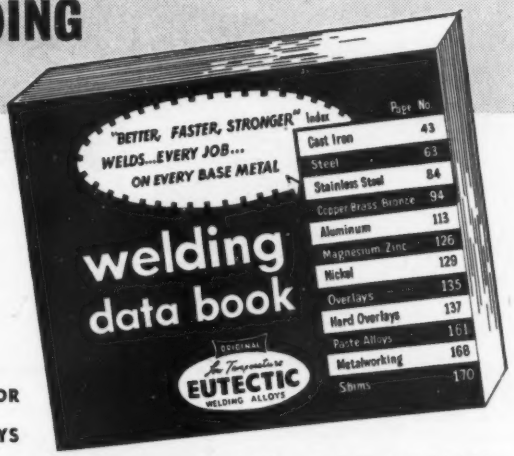

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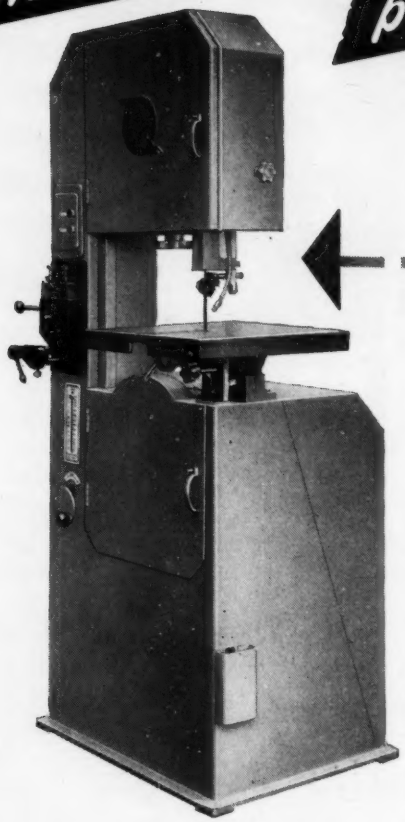

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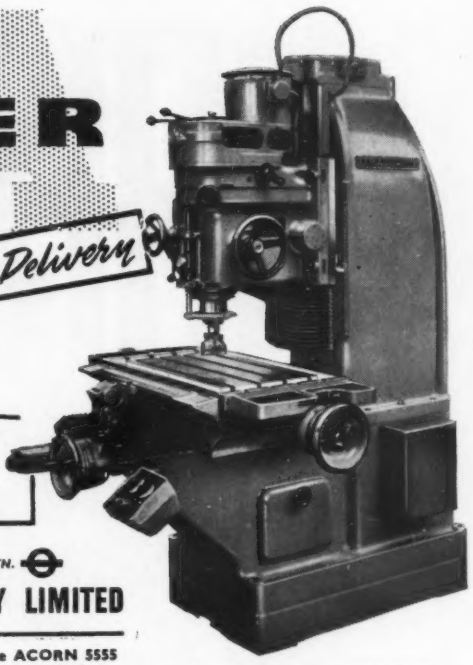

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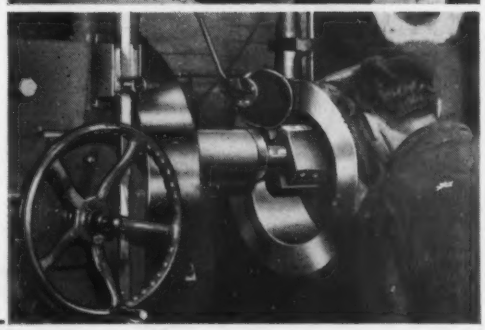

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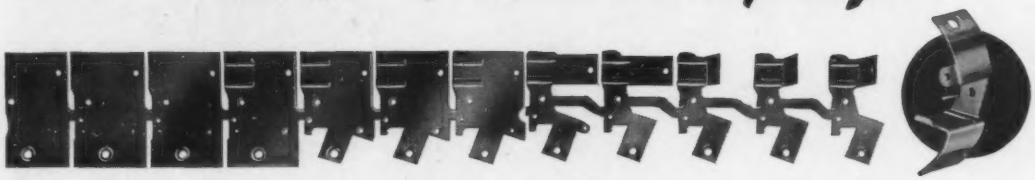

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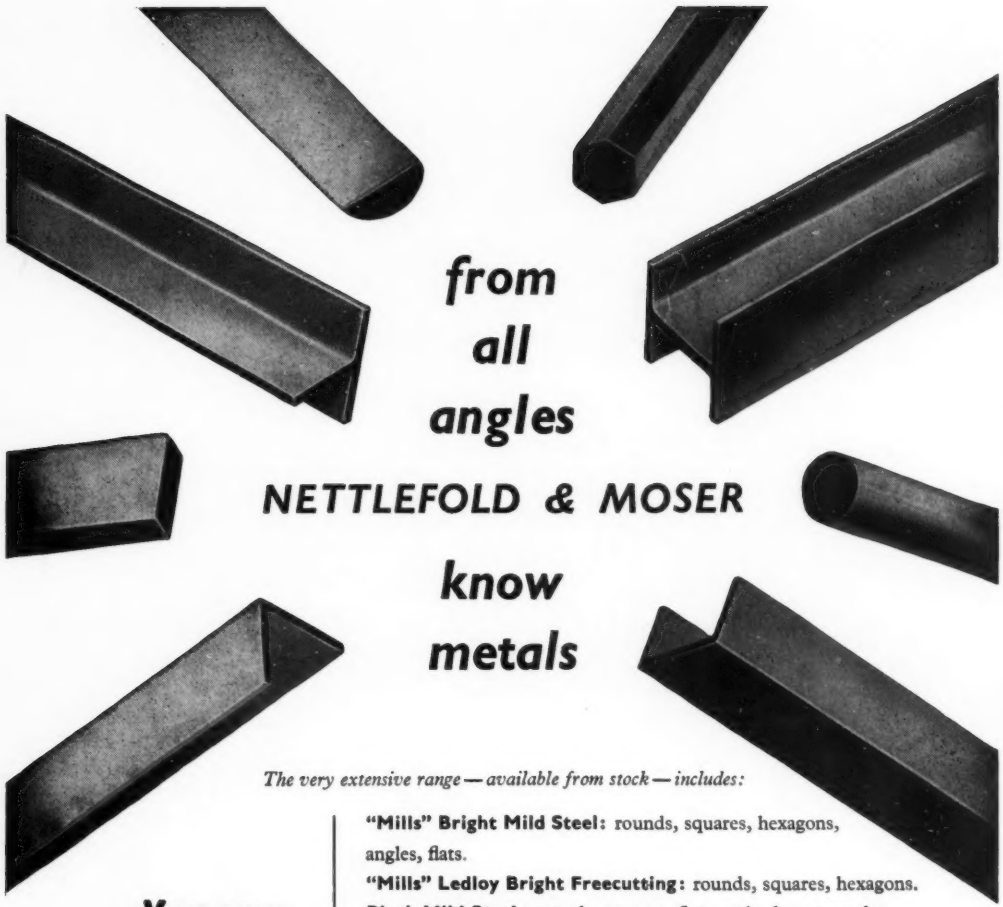

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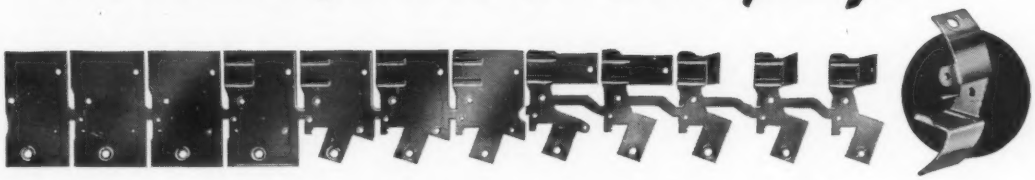

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2. Sturdy construction of machine and its attachments as well as instantaneous braking through monitoring devices, increase tool life and reduce risk of tool breakages.
3. Material is saved because no extra material width is usually required either for piloting or side-cropping. The developed blank is in continuous strip, *not* held in a material webbing which becomes scrap. Material savings up to 25 per cent. are possible. In some cases production can be doubled by making two components from one strip.

ROCKWELL MACHINE TOOL CO. LTD.

For further particulars write or telephone TODAY

WELSH HARP, EDGWARE RD., LONDON, N.W.2. TEL: GLADSTONE 0033

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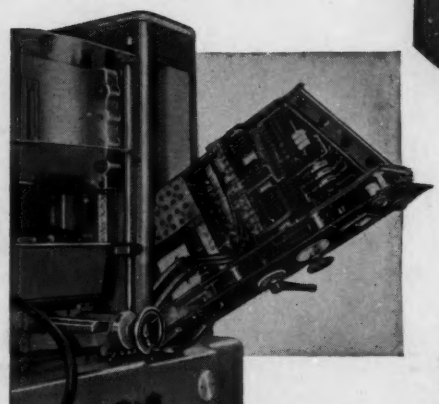
THE *FIRST* SPARK ERODER BUILT AS A PRECISION MACHINE TOOL

ELERODA D1

Today's answer to the making of Drawing and Piercing Dies and the making and reconditioning of Forging and Stamping Dies—Machines the "Unworkable" metals.



A precision Swiss built machine which is today's answer to the machining by electro erosion of metals of any hardness such as hardened steel, tungsten carbide and nimonic without causing distortion of work or alteration of mechanical or physical properties of machined surfaces. The patented electrical circuit combined with the sensitive electro hydraulic servo-mechanism ensures speed of operation and high precision. Six different surface finishes from coarse for roughing to the finest finish are obtainable. 20 power settings. Automatic depth cutout.

ROCKWELL
MACHINE TOOL CO. LTD.

WELSH HARP, EDGWARE RD., LONDON, N.W.2. TEL: GLADSTONE 0033

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EL

EVERY PICTURE TELLS A **NICKEL** STORY

Hygienically gleaming, long-life stainless steels for pots and pans and kitchen sinks make a happy domestic chapter in the nickel story. Yet such easy-to-clean corrosion-resistant nickel alloys are of even greater importance in industry. Aided by Mond experience, there are almost certainly problems that nickel could solve for you. Mond have the resources for research and development and supply technical publications for guidance in the choice and use of modern materials.

Enough Nickel for all needs—

Plan ahead with **MOND NICKEL**

THE MOND NICKEL COMPANY LIMITED, THAMES HOUSE, MILLBANK, LONDON, S.W.1

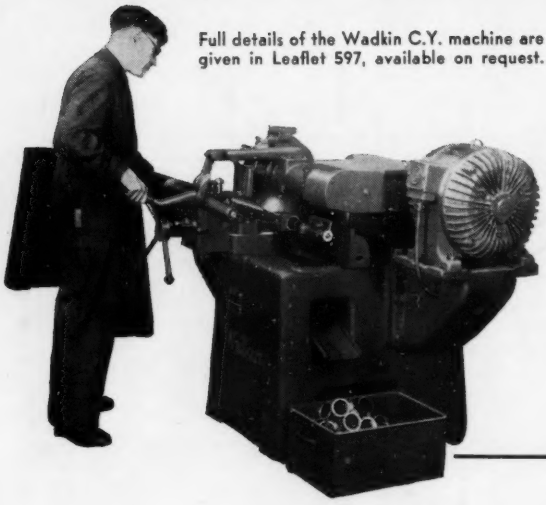
TGA GN23

When answering advertisements kindly mention MACHINERY.

Cutting-off brass bar at

700 pieces per hour!

Wadkin C.Y.I. machine at Messrs. Crane Ltd. Ipswich, cutting-off brass bars for valve parts.



Full details of the Wadkin C.Y. machine are given in Leaflet 597, available on request.

The Wadkin C.Y. is the ideal machine for cutting-off non-ferrous bars or extrusions up to 4in. by 2½in. or 3in. round. It does the job with ease, speed, and consistent accuracy! The material is moved into position by capstan wheel operated feed and a short, easy downward movement of the handle both clamps and cuts through the material. Even after cutting the material is still held firmly until the saw is raised clear and allows components up to 9in. long to fall through the chute. Nothing could be simpler in operation! Unskilled labour can easily maintain high rates of output. If required, machine can be arranged to cut-off up to 3ft. 6in. long.

Wadkin

Wadkin Ltd., Green Lane Works, Leicester. Tel: 68151. London Office: 62 Brook St., W.1. Tel: MAYfair 7048

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THIS IS NEW!

100% ACCURACY AND FINISH

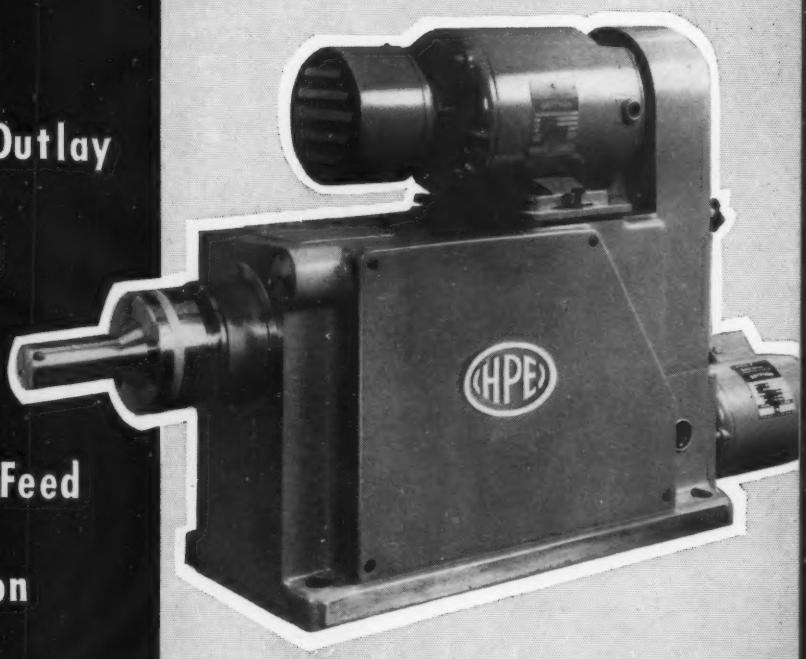
★ Adaptability

★ Low Capital Outlay

★ Space Saving

★ Integral Cam Feed

★ Super Precision Bearings



The FB4F Fine Boring Unit Head illustrated above incorporates an independent feed motion, transmitted to its spindle quill through a simple plate cam, which can be designed to give a fast approach and varying rates of feed. The robust spindle and quill, together with super precision spindle bearings, ensure a high degree of finish and roundness.

These self contained units are readily adaptable for a wide variety of applications without need for costly set ups.

Particularly suitable for mounting on simple base plates together with the necessary work holding fixture enabling single purpose units to be constructed for the minimum of time and cost. Wide range of speeds and feeds obtainable by changing feed cam and motor pulley.

"Descriptive brochure on request."

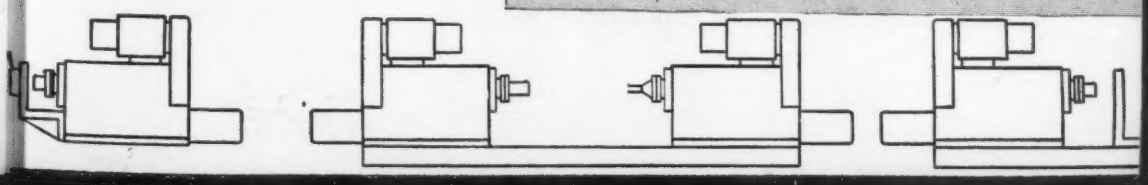
Manufactured by:—

High Precision Equipment Ltd

DESIGNERS AND MANUFACTURERS OF SPECIAL MACHINE TOOLS

BLETCHLEY BUCKS

Phone: BLETCHLEY 3403/4/5



MARBAIX

FOR UNUSUAL MACHINES

MINUTES SLASHED TO SECONDS . . .

on the new

MARBAIX
M58 DISINTEGRATOR

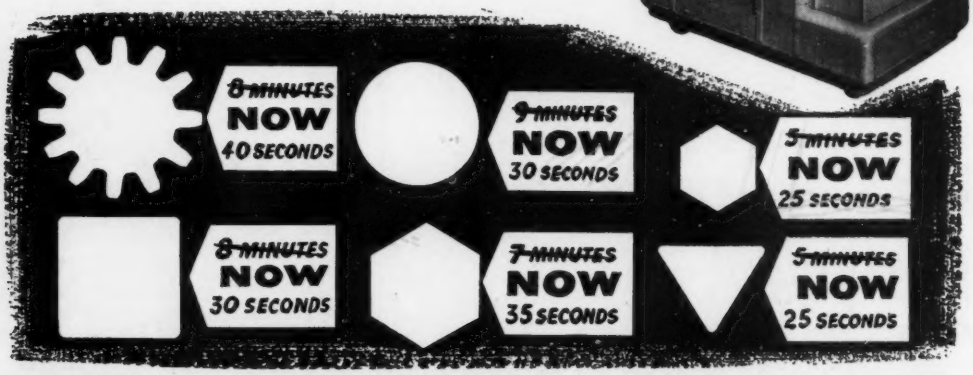
- **REMOVES BROKEN TOOLS WITHOUT DAMAGE TO THE COMPONENT**
- **CUTS HOLES OF ANY SHAPE IN HARDENED MATERIAL, CARBIDES ETC.**

. . . in fact any material through which electric current can pass.

The new MARBAIX M.58 disintegrator removes broken taps, drills, reamers, studs, etc., in a fraction of normal time, without damage to the component.

Holes, too, of any shape can be cut in hardened material for subsequent finishing by grinding or other methods. Note the times for the various examples shown, and write today for full details to Dept. M.I.

*** HERE'S HOW TO CUT COSTS**
Times obtained on Model M58-C (as illustrated)



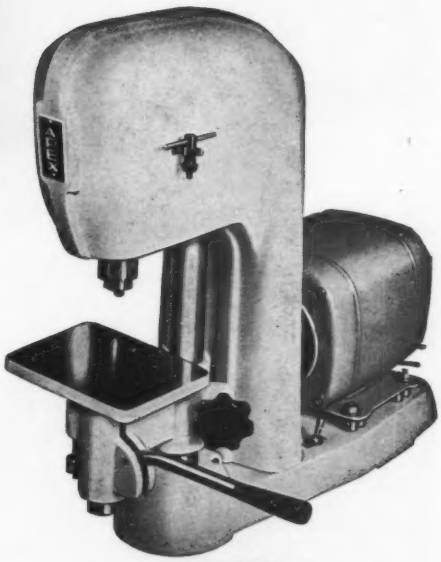
MARBAIX INDUSTRIES LTD
VALIANT HOUSE, VICARAGE CRESCENT
BATTERSEA, LONDON, S.W.11
PHONE: BATTERSEA 8888 (8 lines)

APEX

SENSITIVE TAPPING MACHINE

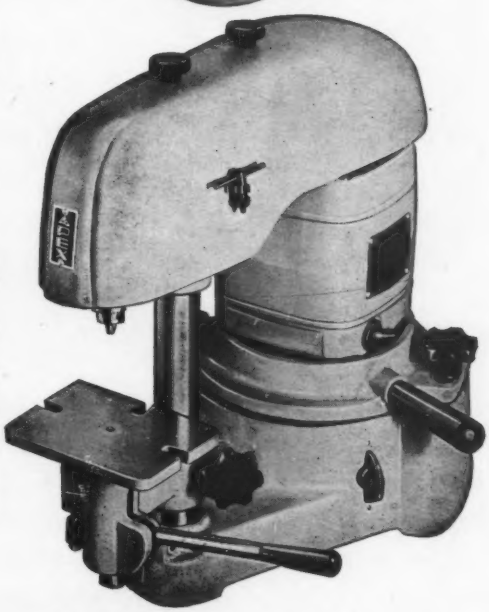
CAPACITY 14 B.A. to ¼in. Whit. in brass.
14 B.A. to 2 B.A. in steel.

The design of this machine is based on many years' experience of tapping small holes, combining speed of operation with maximum tap life. Simplicity and rigidity of construction ensure trouble-free working. The spindle is light, carrying no clutches or other mechanism and being rotated by a friction cone drive.



Both these machines have special quick-action table movement for fast production, plus robust construction. They are supplied complete with ¼ h.p. motor.

Chuck Guards are now available for both machines



Junior SENSITIVE DRILLING MACHINE

¼" CAPACITY SPEEDS UP TO 10,000 R.P.M.

This robustly constructed machine has been specially designed to produce accurate holes from 0·010in. to 0·250in. diameter, meeting the exacting requirements of the horological and instrument trades; it is equally suitable, however, for the general engineering workshop where accuracy and speed are the main considerations.

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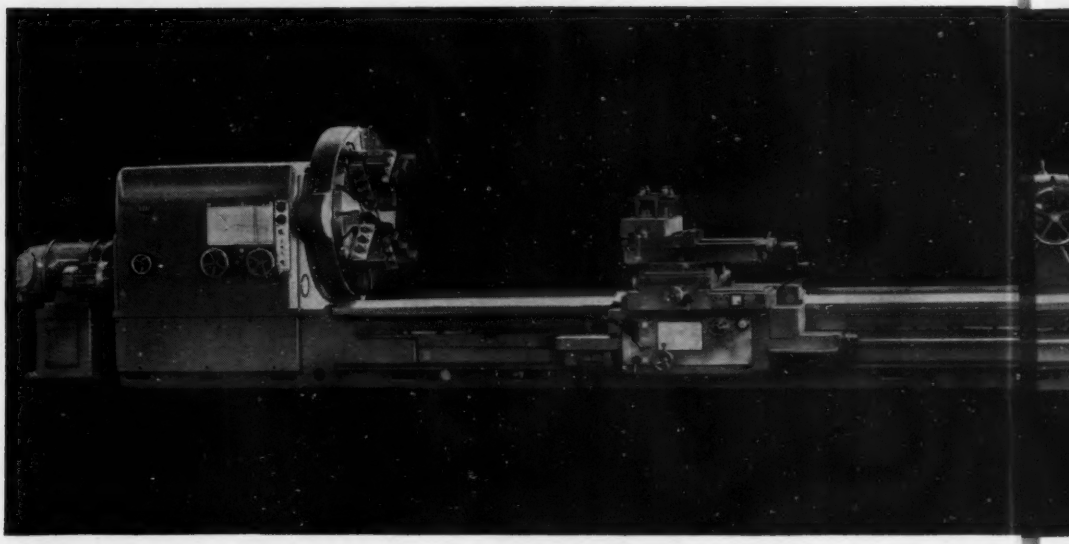
VDF

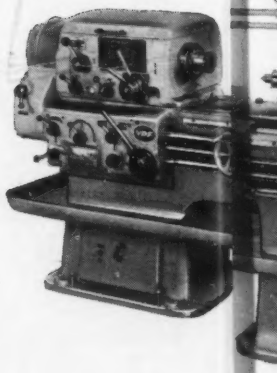
gives you choice!

VDF HIGH DUTY LATHE, type E1400 B

- triple bedways — induction hardened and ground
- saddle runs unimpeded past rests and tailstock
- 24 spindle speeds — 0.9 to 180 r.p.m.
- main drive motor 100 h.p.
- maximum centre distance 394" swing over bed 58½"



Choice of the finest Continental machine tools in the size and capacity to suit your requirements. Turret lathes, high speed precision lathes, copying lathes, standard and heavy duty centre lathes, boring and planing machines — these are a few of the wide range of standard and special-purpose VDF machines, each available with a complete selection of extra equipment. Contact Sykes Machine Tool Co. Ltd. now for details of the machine you want in the size you need.



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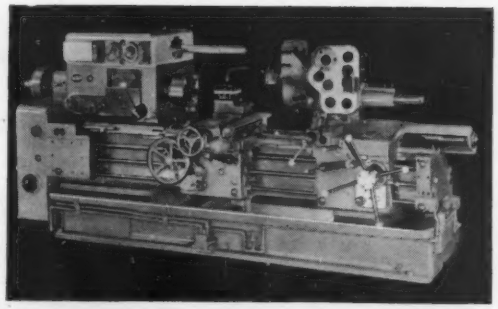
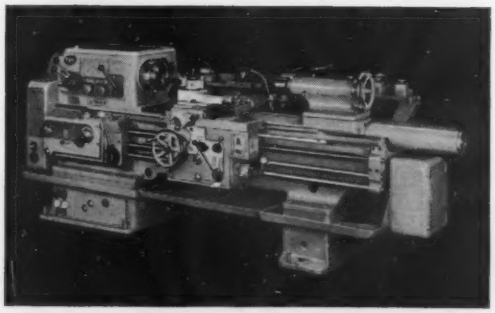
VDF TURRET LATHES, type RS

- fitted with pre-selector system for increased production
- feeds, speeds, direction of rotation, instantaneous stopping all programme controlled
- four models available with capacities up to 4″
- hardened & ground bedways and rapid traverse in all directions
- swing over bed up to 22 1/16″ — 19 h.p. motor



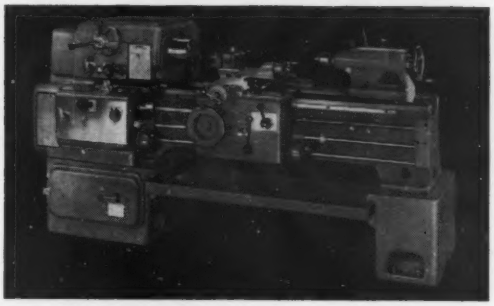
VDF UNICOP COPYING LATHES, type 1

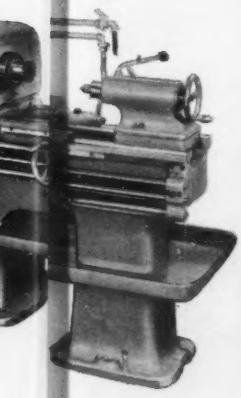
- for normal *and* copy turning
- ideal for workshops where single-purpose copying lathe is uneconomic
- electronic — hydraulic and ultra sensitive
- copying traverse up to 29½″ and cross slide to 5″
- three types available



VDF LATHES, types 36 and 44

- extremely versatile, with high degree of finish
- 30 spindle speeds from 11 to 2240 r.p.m.
- three models available with swing over bed up to 18″ and centre distance up to 118″





VDF HIGH SPEED PRECISION LATHE, type 18RO

- suitable for wide variety of work or quantity production
- 12 spindle speeds from 17 to 2000 r.p.m.
- high speed headstock available — top speed 4000 r.p.m.
- swing over bed 15″ — centre distance up to 79″
- large number of feeds
- simple controls
- extremely accurate

Sole British Agents

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Machine Tool Co. Ltd

Hythe Works, The Hythe
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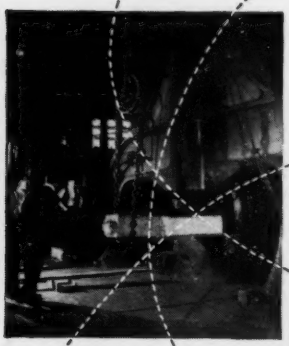

We make engineering forgings for all purposes. We forge in tool steels and alloy steels, in stainless and heat-resisting steels and in Nimonic and titanium. Where required, forgings are normalised, annealed or heat treated to specification. In a word—if you use forgings use Doncasters.

DONCASTERS ◇
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FORGINGS · DROP FORGINGS · TOOL STEELS · HARDENED STEEL ROLLS

F.49

HIGH PRODUCTION SURFACE GRINDING at MORRIS

An arrangement of stepped magnetic chucks on the 48" diameter rotary table of this Lumsden model MLS Single Headed Continuous Grinder ensures the maximum output of connecting rods at the Coventry works of Morris Motors. Both faces are ground in a transfer system where a component roughed on one chuck is finished on the next. The power, speed of operation and rigidity of this machine are features common throughout the extensive range of Lumsden Surface Grinders, which includes machines with single or multiple heads as required. Write for our illustrated catalogue which contains full details and specifications.

LUMSDEN

MODEL 91 MLS

Continuous SURFACE GRINDERS

Manufacturers
LUMSDEN MACHINE Co. Ltd. GATESHEAD
Sole Distributing Agents:
ALFRED HERBERT LTD., COVENTRY

LOCALISE YOUR LEAK TROUBLES - INSTANTLY!

SPECTRA

SPOT-LEAK

THE NEW METHOD

of detecting leaks in equipment employing air or gases under pressure

One liberal application of SPOT-LEAK makes a leak immediately VISIBLE, giving off either a frothing action or a cumulative succession of larger bubbles according to the degree of the leak. It will not damage metal, rubber, wood or plastics and is non-poisonous, non-volatile and harmless to skin or clothes.
SPOT-LEAK requires ONE APPLICATION ONLY by brush or spray—and no need to clean off! In ½ pt. and 1 pt. Polythene bottles (5/6 and 9/-) or 1 gal. tins (32/6).

SPECTRA CHEMICALS LIMITED

Makers of SPECTRA-COLOR marking and identification fluids

SPECTRA WORKS, HIGH ST., CATERHAM, SURREY

Telephone: Caterham 3182 & 2293

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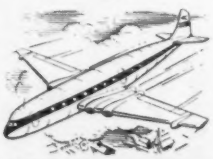
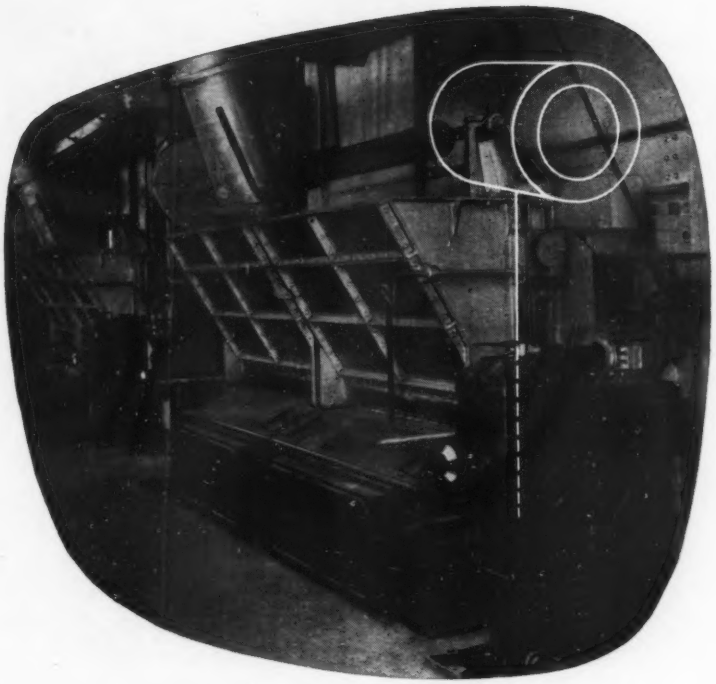
On Hospital equipment using medical gases, or on industrial plant where compressed air, coal gas or calor gas is used SPOT-LEAK is invaluable for installation and checking tests as well as for the detection of suspected leaks on established systems.



SPOT-LEAK is of particular use to the Aircraft industry on manufacture, field servicing and maintenance for both pneumatic and hydraulic systems. In garages it is ideal for testing for leaks round sparking plug seats, blown gaskets, tubeless type wheel rims etc.

SPOT-LEAK finds the leaks in pipes, valves, joints and radiators of central heating or coal gas plant in the home. It is invaluable for testing calor gas lighting or heating systems in Caravans or Boats where space is limited and headroom small with the necessity to work by flash-light.

NO MAINTENANCE—



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These Travelling-Grate Stokers made by Babcock & Wilcox supply annually 22,000 tons of coal to boilers which in turn supply the entire steam requirements of the large heavy-chemical works of Dorman Long. MORGANITE CARBON BEARINGS situated in the hot zone have to withstand severe treatment.

MORGANITE CARBON BEARINGS are the answer to this problem—they will answer yours today. Please write or 'phone for leaflet SD.63 or ask for one of our Technical Advisers to call.

MORGANITE CARBON BEARINGS withstand high temperatures, will run in liquids; resist chemical atmospheres and corrosive conditions; need no lubrication; are useful for inaccessible positions; are non-contaminating and eliminate maintenance.

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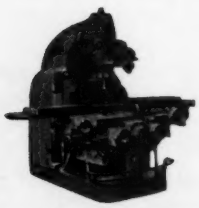
Electromagnetic Multiple-Plate Clutches

The sound design and outstanding efficiency of our electro-magnetic multi-plate clutches has ensured their wide adoption for machine drives of every type.

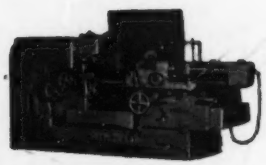
Multiple thin magnetic steel plates form an exceptionally compact unit, capable of transmitting very high torques. Operation is unaffected by oil and the clutches are therefore very suitable for gear box operation. No adjustment is necessary, as the clutches will function without an air gap.

TYPICAL APPLICATIONS OF OUR ELECTRO-MAGNETIC MULTI-PLATE CLUTCHES



VERTICAL MILLING MACHINE

The feeds, either forward, rapid traverse or rapid reverse, are charged by means of electro-magnetic multi-plate clutches.



TURRET LATHE

On which spindle speed changes are made through electro-magnetic multi-plate clutches.

VERTICAL TURNING AND BORING MILL

On which the electro-magnetic multi-plate clutch ensures gentle, but firm braking.

SIEMENS - SCHUCKERTWERKE A.G., BERLIN - ERLANGEN

***Sole Selling Agents in Great Britain:*— SIEMENS - SCHUCKERT (GREAT BRITAIN) LTD.**
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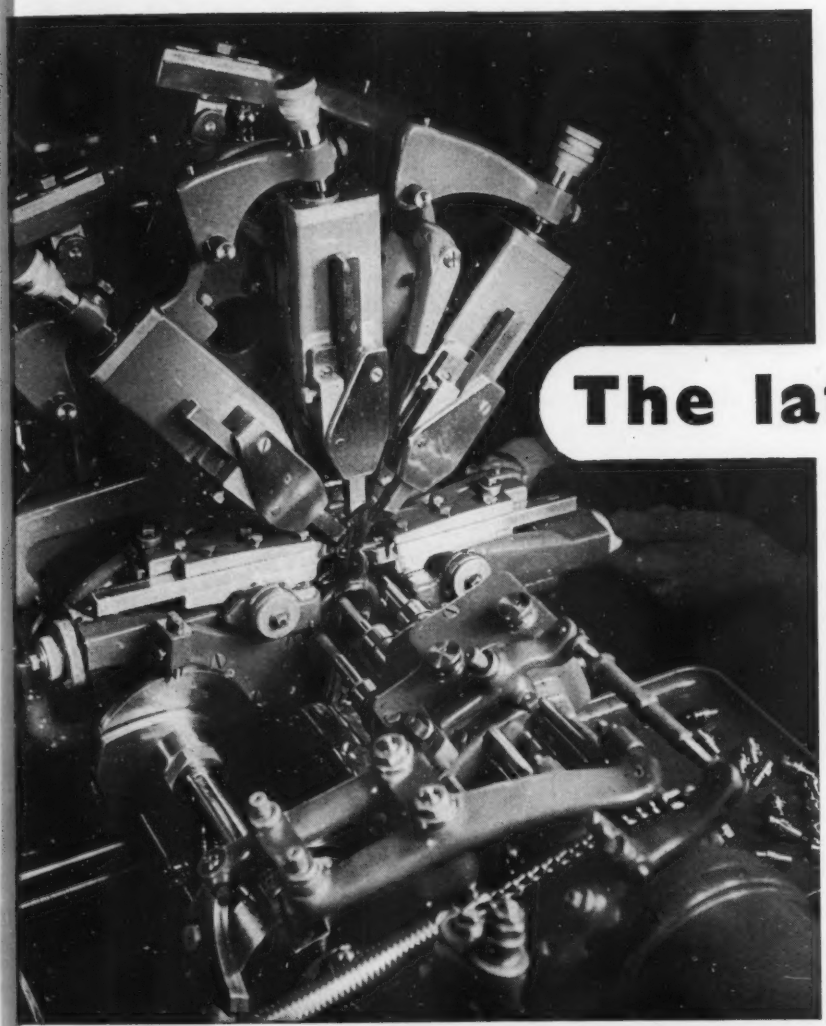

The latest

TORNOS

SLIDING HEAD AUTOMATIC

MODEL R.16

● This model R 16, built by the world's largest and oldest producers of Swiss-type automatics, is the last word in performance, precision and production capacity.

Stock capacity ⅜in. dia., with a maximum turning length of 3¼in. or 6in., according to type of cam. 28 spindle speeds 485 to 5,450 r.p.m.

TORNOS Automatics are available in the following sizes:-

Model	M4	M7	R10	R16	M25/28
Max Dia Bar	5/32	9/32	15/32	5/8	1 3/32

Telephone Coventry 40606 for full details

TORNOS SALES COMPANY, (E. M. Vaughan Ltd.) BROADGATE HOUSE, COVENTRY

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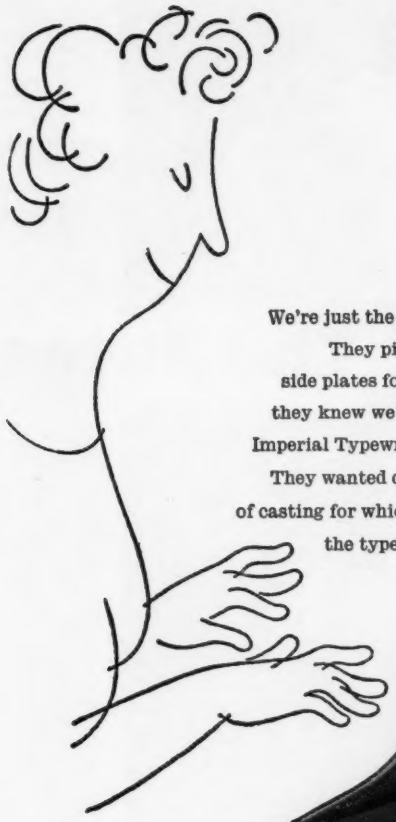
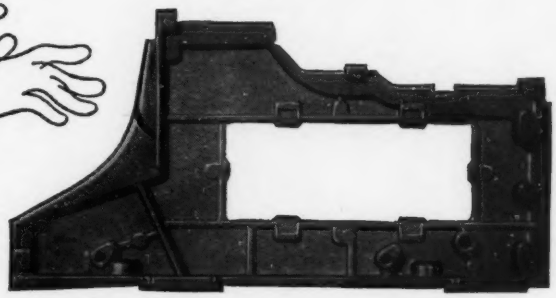


why pick on us?

We're just the type for Imperial Typewriters.
They picked on us to cast the aluminium side plates for their new typewriter because they knew we'd do it quickly, cheaply and well.
Imperial Typewriters are just the type for us.
They wanted quantity production of the type of casting for which we are well equipped. If that's the type of job you want done—pick on us.



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the whole in one

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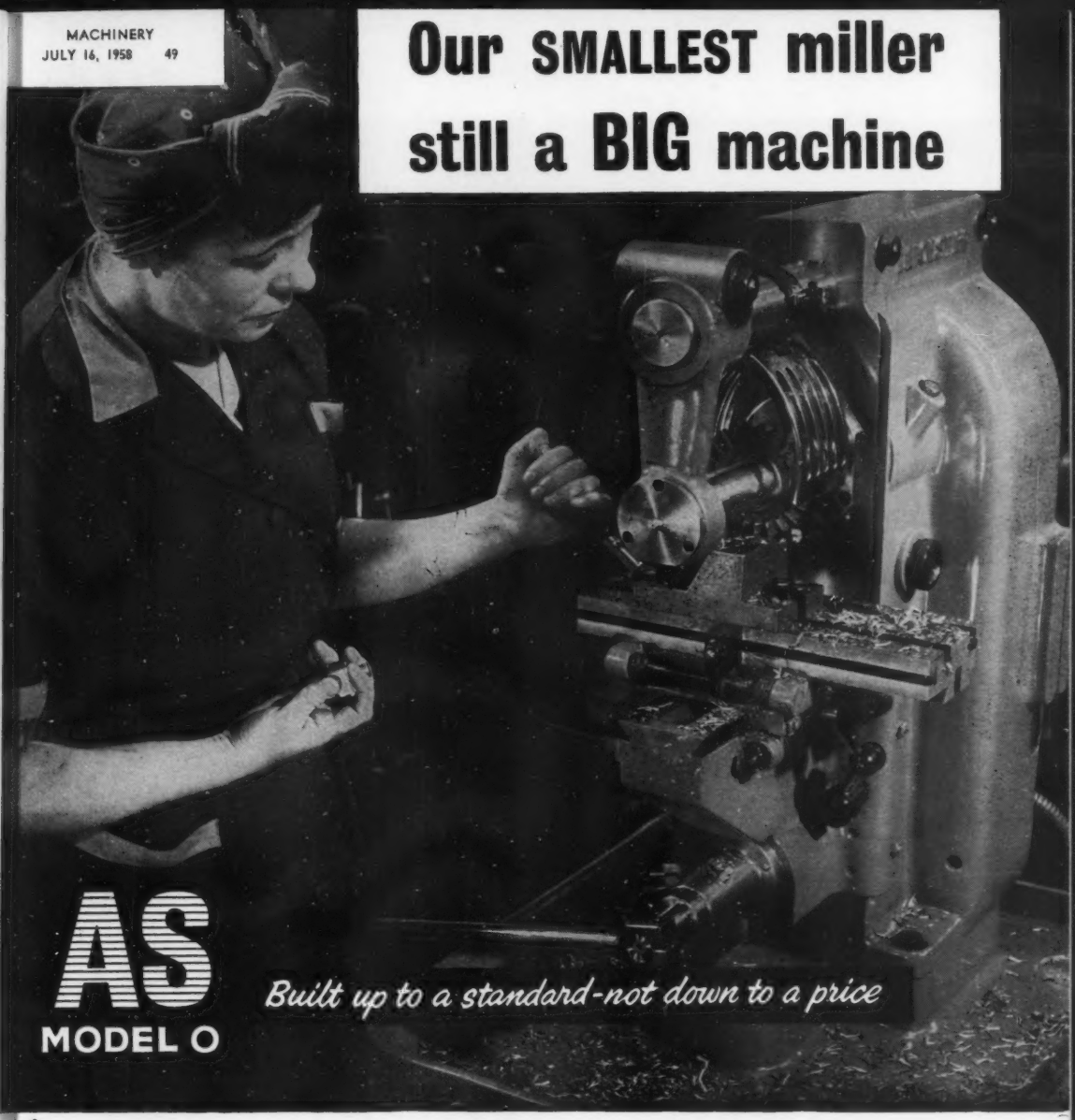
CERTIFIED ZINC ALLOY ZAMCA DIE CASTERS

CRC37

Our SMALLEST miller still a BIG machine



AS
MODEL O

Built up to a standard-not down to a price

Nothing small about our Model 'O' range of horizontal milling machines. However hard the going, short of obvious overloading, they can take it. That's because they are solidly, generously, heavily* built for a lifetime of honest service with the absolute minimum of maintenance. 20 different variations of an extremely rigid central theme; hand or automatic feeds; large range of spindle speeds right down to 150 r.p.m. Angular contact ball-bearing spindle and ball-bearing arbor bracket allow spindle speeds up to 4,000 r.p.m.

* Weight of model illustrated 9 cwt. (1,008 lbs.). Table sizes 18½" × 5", 17½" × 5" and 12" × 4½"

Write for fully illustrated leaflet

ADCOCK & SHIPLEY LTD

P.O. Box 22, ASH STREET, LEICESTER

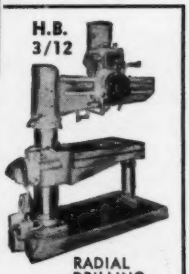
Telephone: Leicester 24154-5-6 **Telegrams and Cables: Adcock Leicester**

Many Types for EARLY DELIVERY

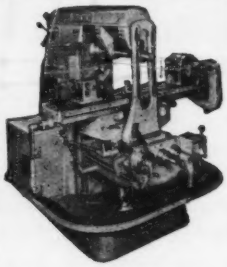
HALIFAX TOOL CO. LTD. *use* RICHMOND MACHINES

The photograph shows a Richmond No. 4 Universal Milling Machine fitted with Universal Milling head in use at the Halifax Tool Co. Ltd. This machine is all-geared for high-speed work to critical limits.

THE 600 GROUP OF COMPANIES



H.B. 3/12 RADIAL DRILLING MACHINE



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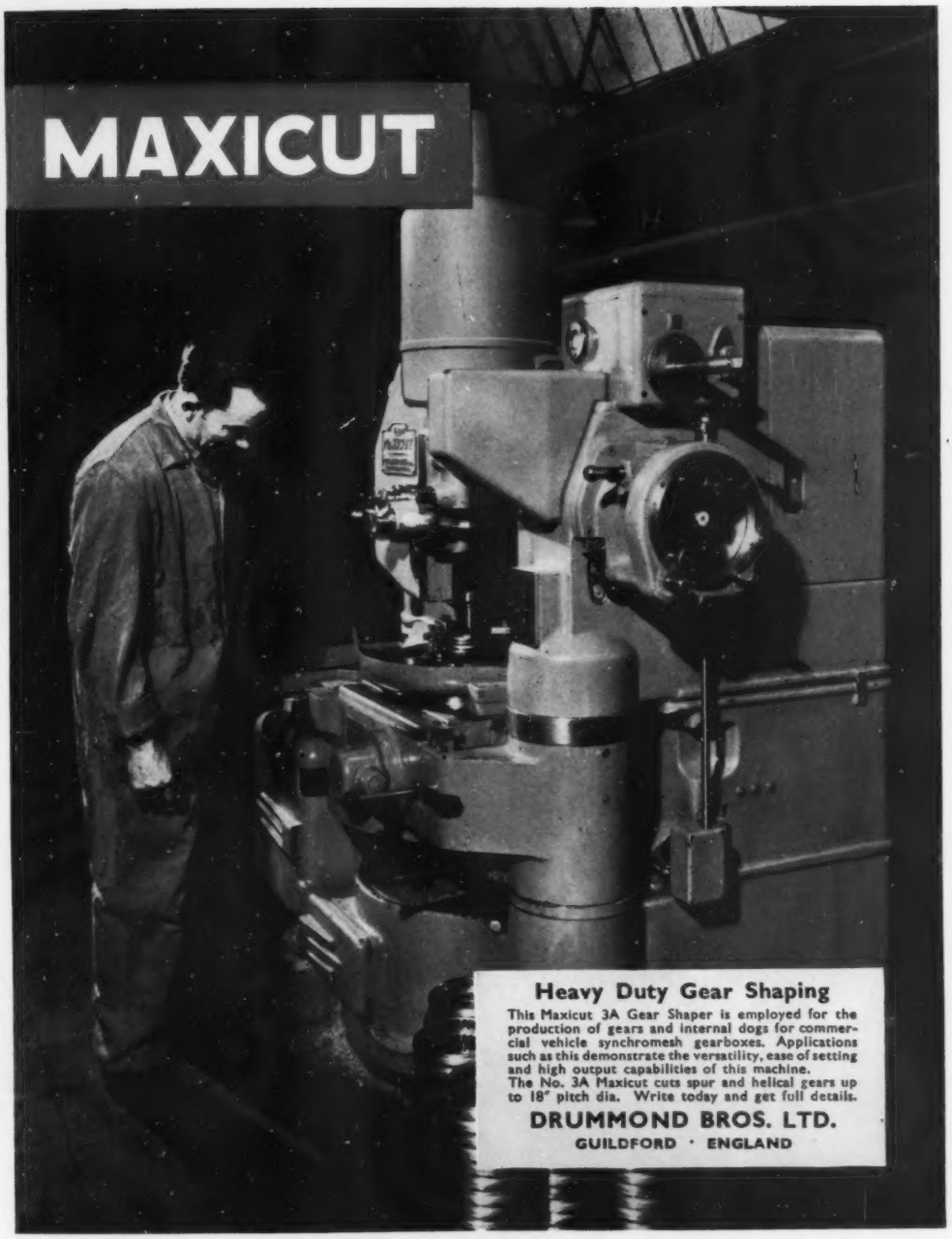
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Heavy Duty Gear Shaping
This Maxicut 3A Gear Shaper is employed for the production of gears and internal dogs for commercial vehicle synchromesh gearboxes. Applications such as this demonstrate the versatility, ease of setting and high output capabilities of this machine.
The No. 3A Maxicut cuts spur and helical gears up to 18" pitch dia. Write today and get full details.
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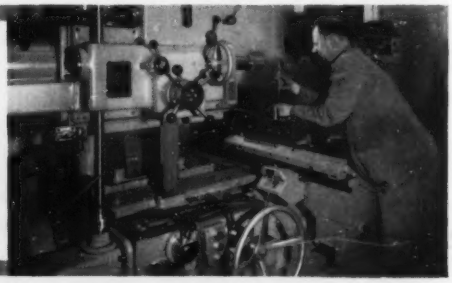

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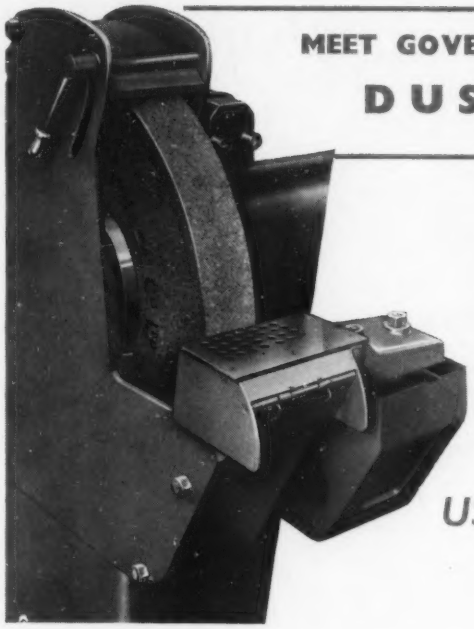

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These machines embody the B.S.C.R.A. Patent System of Dust Control and comply with the new Government Regulation 1 of the Grinding of Metals (Misc. Indus.) Regulations, and Regulation 7, para. (6) of the Iron and Steel Foundries Regulations, 1953.

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"TWIN DRIVE"

FLOOR GRINDERS

- ★ **Separate driving motors provide independent drive and control to each wheel.**
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Built in three sizes with wheels 30in. dia. 24in. dia. and 18in. dia. respectively. Also available in the Single Wheel Type in all sizes. Details on request.

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MAX. DEPTH HOLE 3½in.

MAX. TRAV. STROKE 6in.

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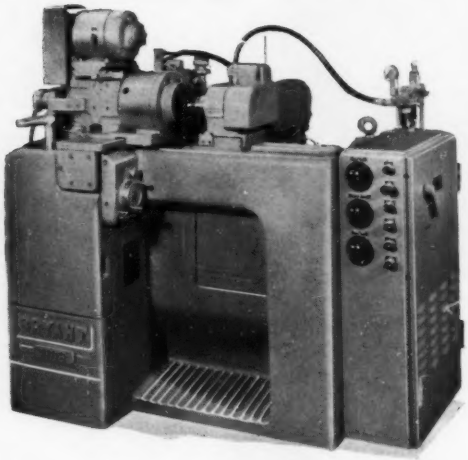

WORKHEAD ADJUSTABLE TO 45°

WILL GRIND UP TO 90° INCLUDED ANGLE

will give you TENTHS precision at high production rates

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designed to give the greatest accuracy for parallelism and roundness

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arranged for high frequency wheelheads - - - belt drive wheelheads - - - - or both

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There is no substitute for experience

Experience counts in every walk of life, but in no other job is experience so vitally necessary as in the design and building of machines such as large power presses, where the ability to turn out large numbers of high quality pressings at an economic rate depends so much on inbuilt robustness, accuracy and reliability.

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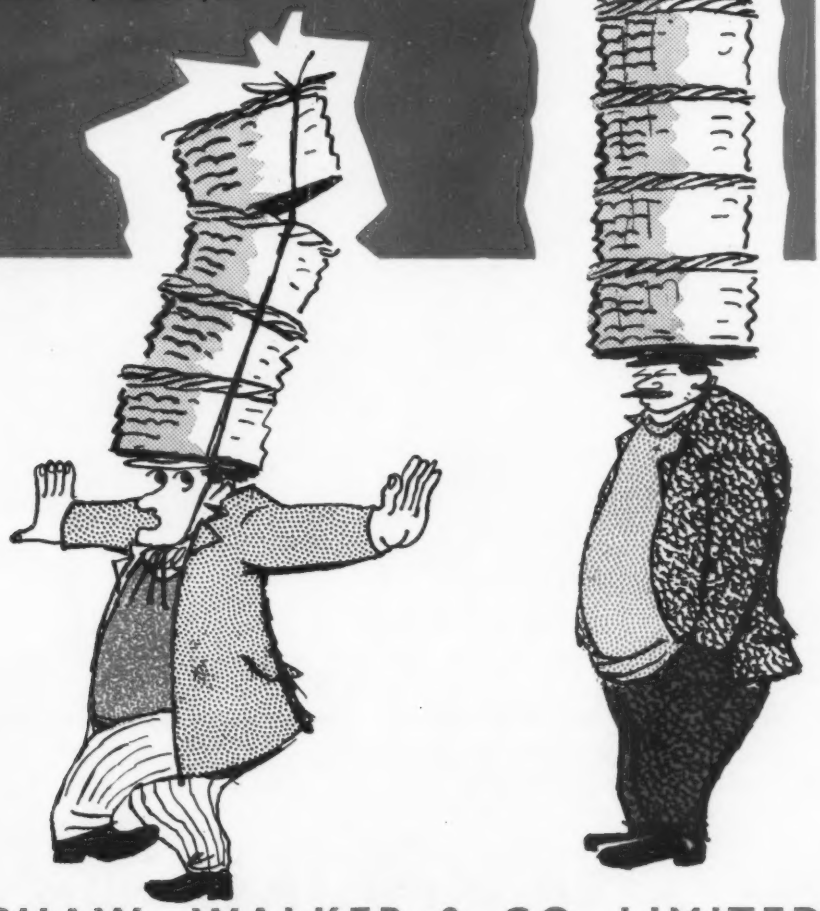

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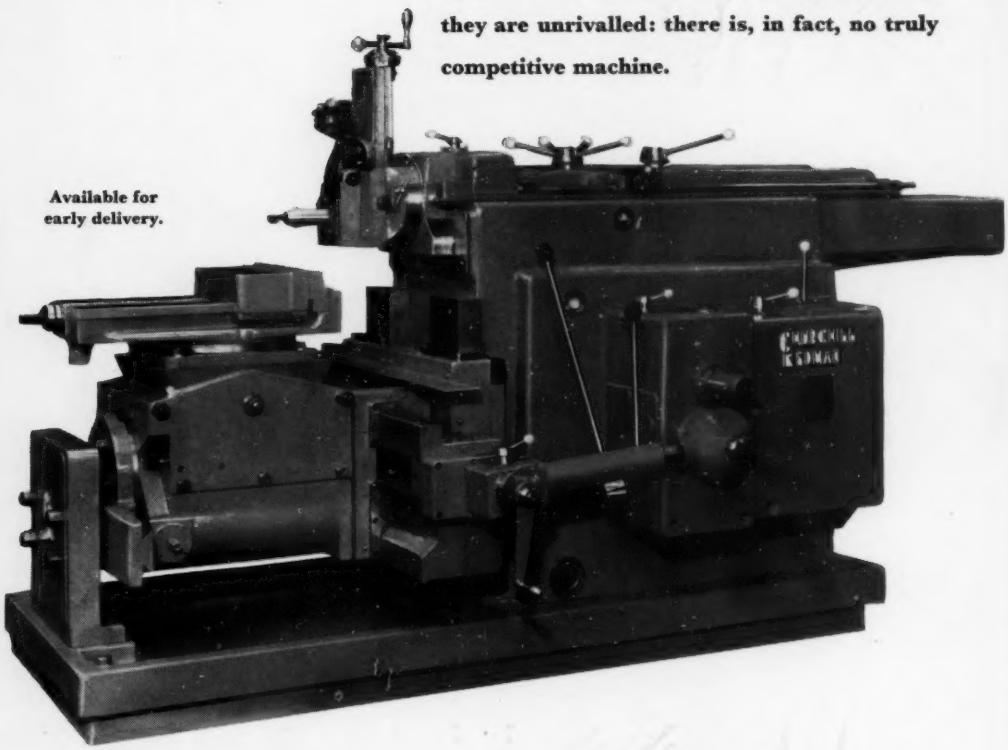
UNCHALLENGED LEADERSHIP

18″ & 24″ STROKE HEAVY DUTY SHAPING MACHINES

Plain or Universal Tables

Churchill-Redman Heavy Duty Shaping machines are in a class of their own. In design, specification, construction and performance they are unrivalled: there is, in fact, no truly competitive machine.

Available for early delivery.



Among the many design features that give CR Heavy Duty Shaping machines their unique performance are:

- **Ram ways cast integral with shaper body.**
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- **Feed and power elevation to table.**
- **Totally enclosed cam-operated feed mechanism.**

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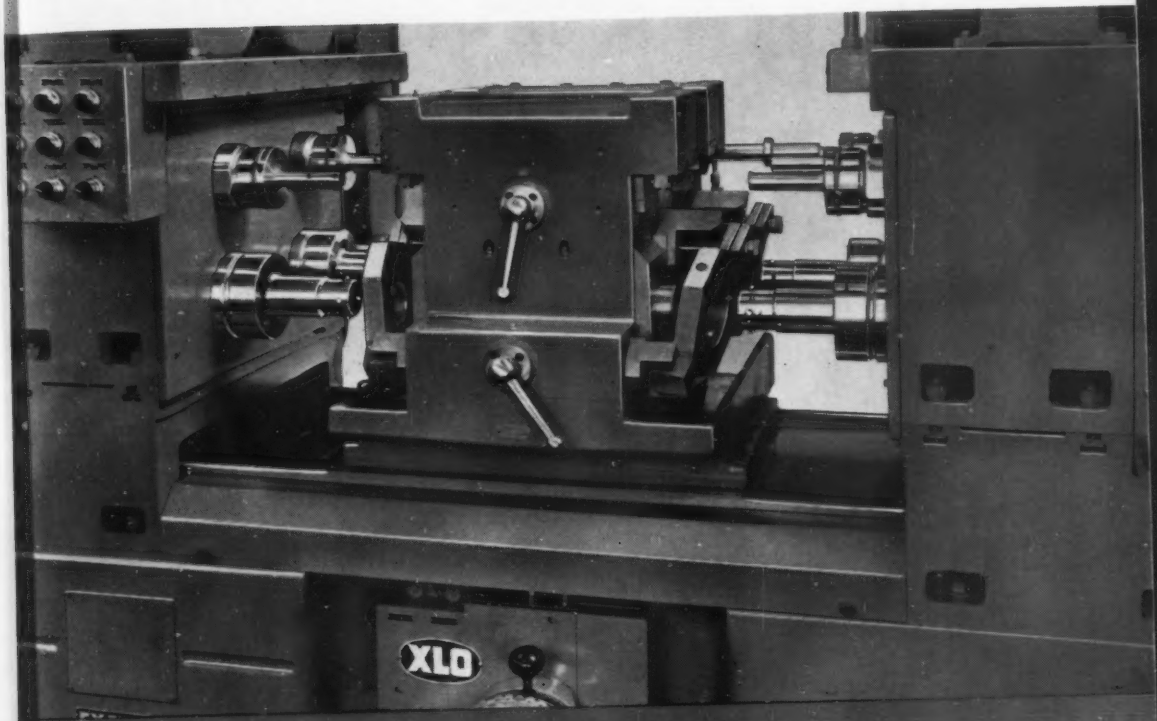
* BORING CONNECTING RODS . . .



*220 per hour!

This is a typical EX-CELL-O set-up in a well-known automobile factory, where EX-CELL-O machines have proved their ability to reduce costs and improve finish on a wide variety of work. Both the large and small ends of the rods are machined and the production rate is 220 pieces per hour. We invite you to investigate the cost reducing possibilities of EX-CELL-O machines for your own work. No obligation.

EX-CELL-O

STYLE 112C SENIOR
PRECISION BORING MACHINE

EX-CELL-O CORPORATION (MACHINE TOOLS) LIMITED
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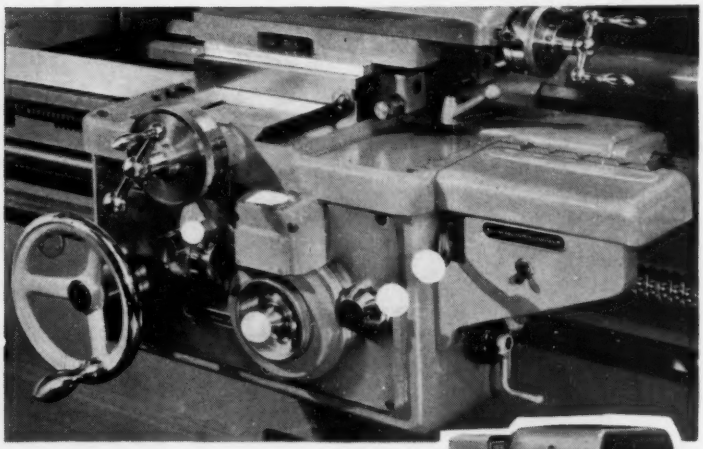
PUSH BUTTON CONTROL

The main feature is the speed control engagement, dis-engagement and reversing of the spindle. The running speed is shown on an illuminated glass panel in full view of the operator. An inching switch for setting up purposes, a signal lamp and an emergency cut out are fitted to the headstock.

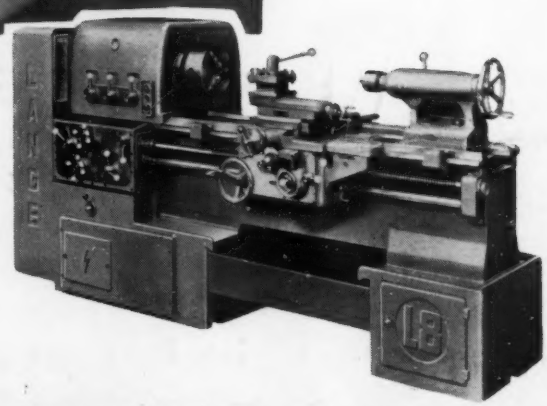
The operations necessary for going through the whole speed range are extremely simple and with a 12 h.p. capacity motor, the speed range covers 22 to 2,000 r.p.m. by P.I.V. Power controlled infinitely variable speed unit. At the minimum speed of 22 r.p.m. there is a power output of 8 h.p.

AUTOMATIC END CONTROLLING ATTACHMENT

This special equipment is mounted to the apron of the lathe and saves lengthy measurements of turning lengths, formerly directly taken from the workpiece. With this attachment, the operator selects the desired turning length on the optical length dial and starts the end feed. When the required turning length is obtained, the attachment cuts out the feed by itself. When two different turning lengths are required for the same workpiece, the first length will be limited by the automatic attachment, the second one by a fixed stop. Accuracy will be the same for both.



LANGE



Specification

Height of Centres	19¾in. or 12in.
Hole through Spindle ..	.. 2⅜in. dia.
Speed (infinitely variable) ..	22/2,000 r.p.m.
Longitudinal Feeds (45) ..	0·002in./0·049in.
Transverse Feeds (45)	0·0005in./0·0165in.
Distance between Centres ..	3ft. 3in., 5ft. 5in., 6ft. 6in., 8ft. 3 in. or 9ft. 6in.

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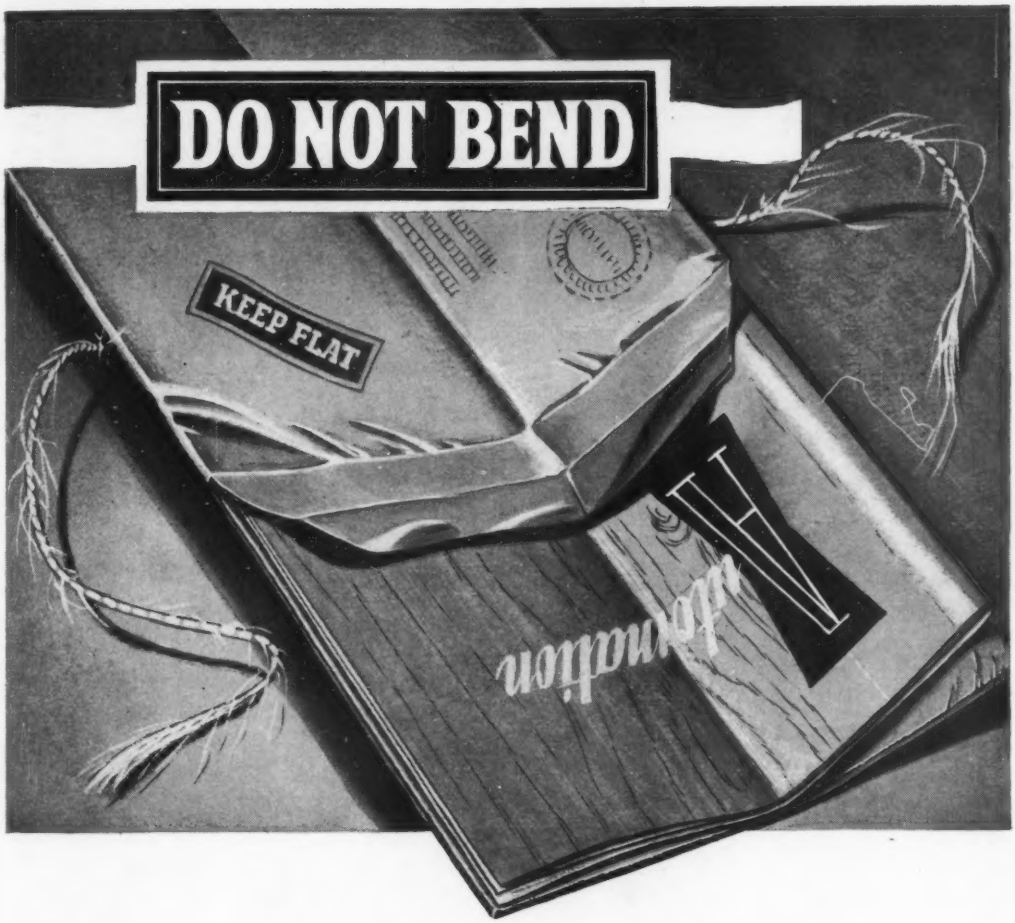

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Write for a copy of "Automation and Electroplating" . . .

Whether your production is large or small, you will find that it makes interesting reading.

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This is a Dallow Lambert Wet Deduster. The dust coming into it is wetted and deposited as sludge, which can then be taken away quickly and easily. The Wet Deduster has no pumps or spray nozzles, does not need a continuous supply of running water, and is practically maintenance-free. Where explosive dusts are being handled, special safety features are built into the collector, which are more than adequate for the requirements of the Factories' Act. The Wet Deduster is not our only answer to dust. We have smaller units like the versatile Drytex and Dustmaster units on the one hand and complete plant installations incorporating fabric filters and cyclones on the other. So see us for dust and see if we can't settle it!

see us for dust

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DUST CONTROL EQUIPMENT FOR INDUSTRY

There's a resident Dallow Lambert engineer in your area

DALLOW LAMBERT & COMPANY LIMITED, THURMASTON, LEICESTER

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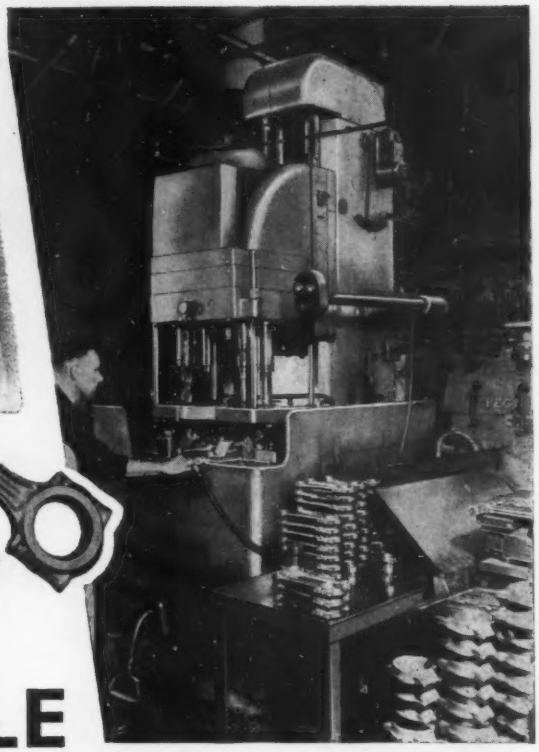
* Faster production on long runs



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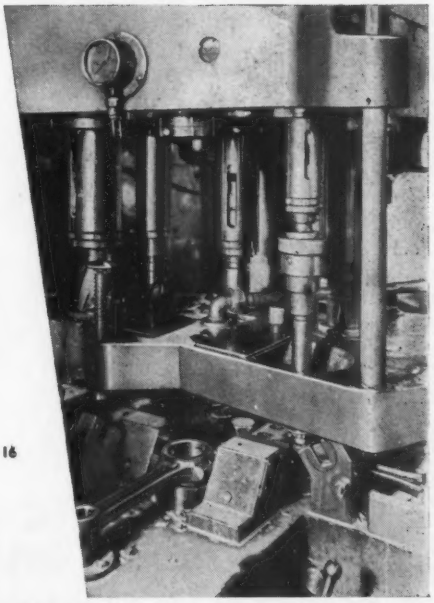
HYDRAULIC MULTIPLE

cuts costs on 'JAGUAR' connecting rods

At Jaguar Cars Ltd., Coventry, this Size 2 ARCHDALE hydraulic feed multi-drill is fully meeting the demands of expanding production schedules. Using a four-station indexing table, with one loading and three working positions, connecting rods are produced at fast rates. Small ends are drilled and reamed, and the large ends are core drilled and bored. Small end bore is ⅝in. dia., and large end 2.200in.

If your problem calls for standard or special multi-drilling ARCHDALE have the answer. Ask for production estimates.



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Our specialised equipment, including the most up-to-date electric melting furnaces, mechanical handling and heat-treatment plant, is capable of meeting all your needs for castings in carbon and alloy steels.

Close laboratory control at every stage—rigid adherence to specification, physical and metallurgical—dimensional accuracy and surface finish—ensure that BAKERSTEEL castings meet your every demand.

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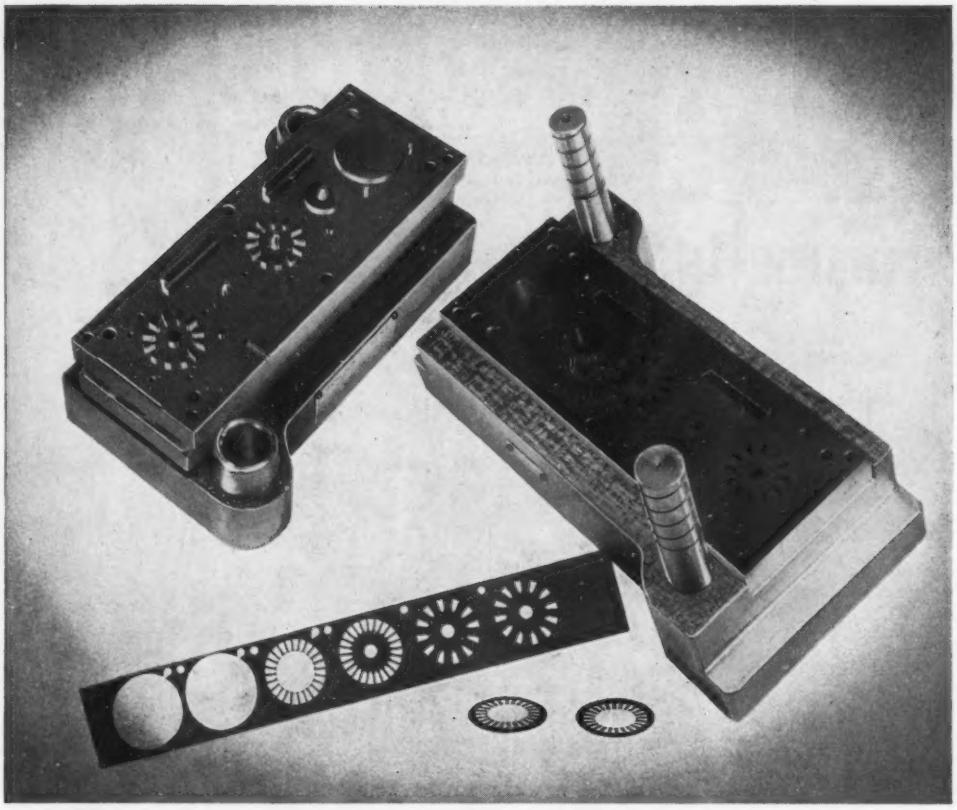

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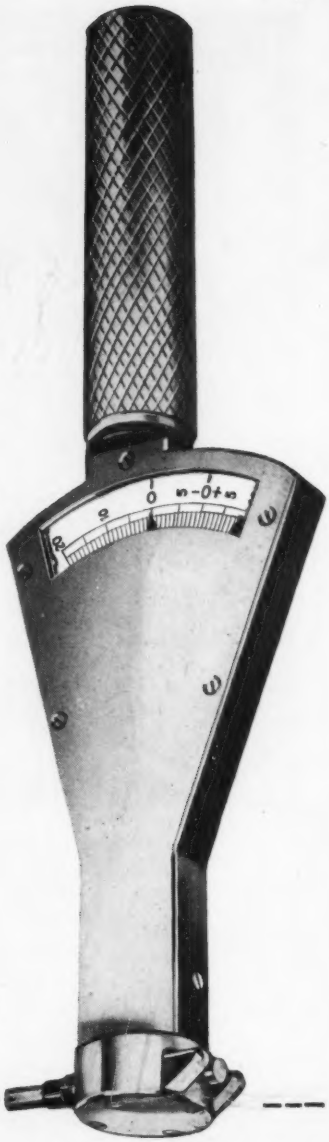

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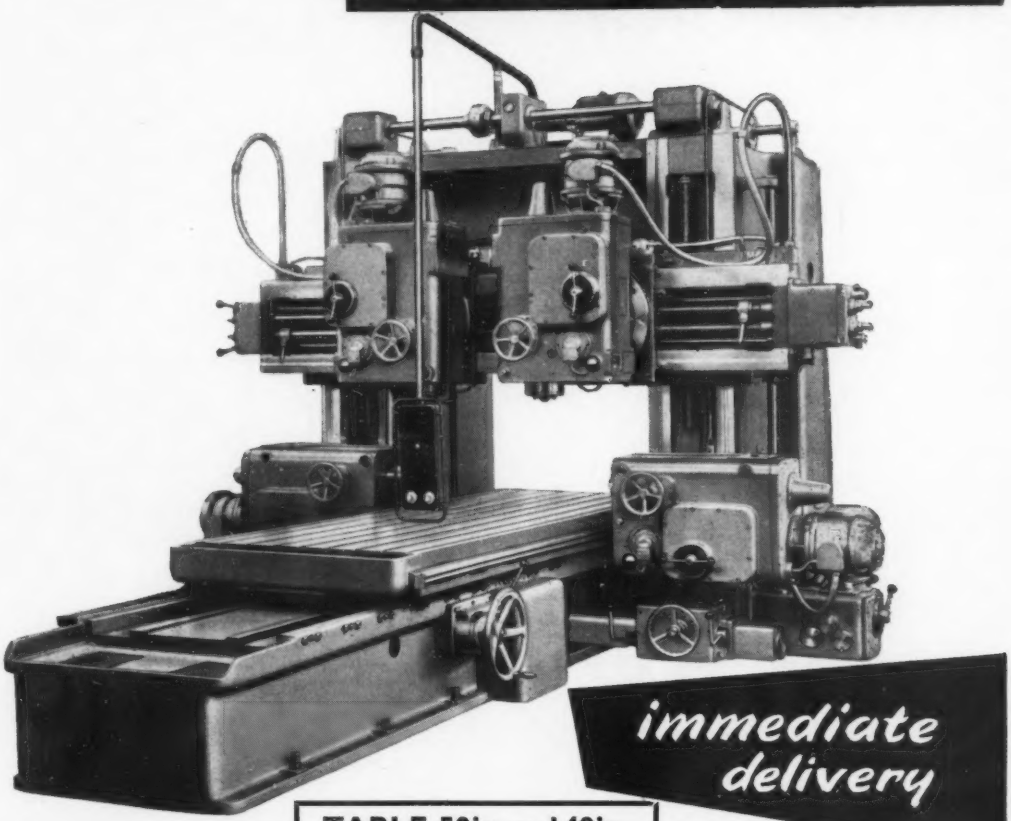

immediate delivery

TABLE 50in. x 140in.

- Wide range of Spindle Speeds enabling use of high-speed steel and cemented carbide tipped cutters.
- Table speeds infinitely variable.
- Independent drive to individual headstocks, individual drive to table and headstock feeds.
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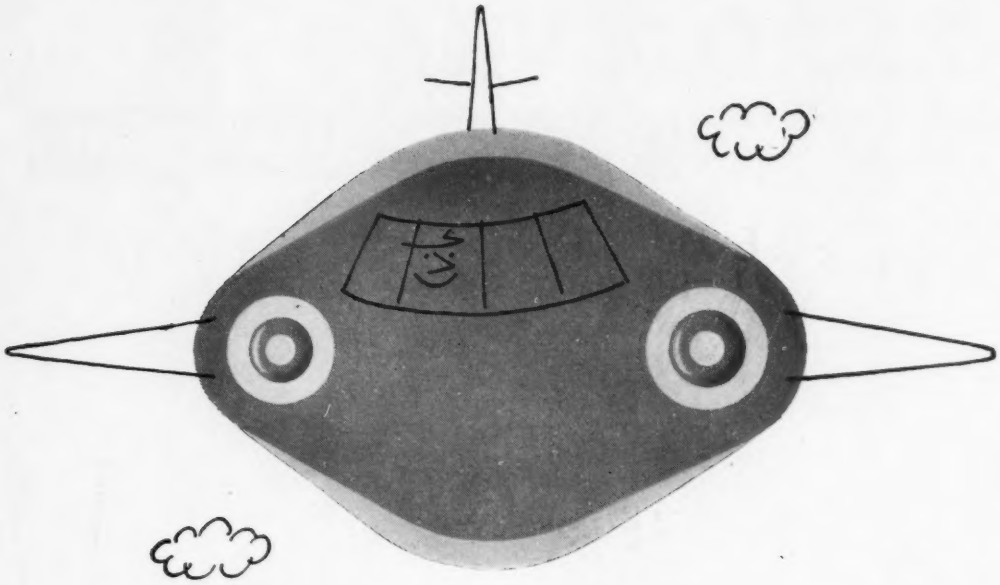

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Better die sets—and at better prices.

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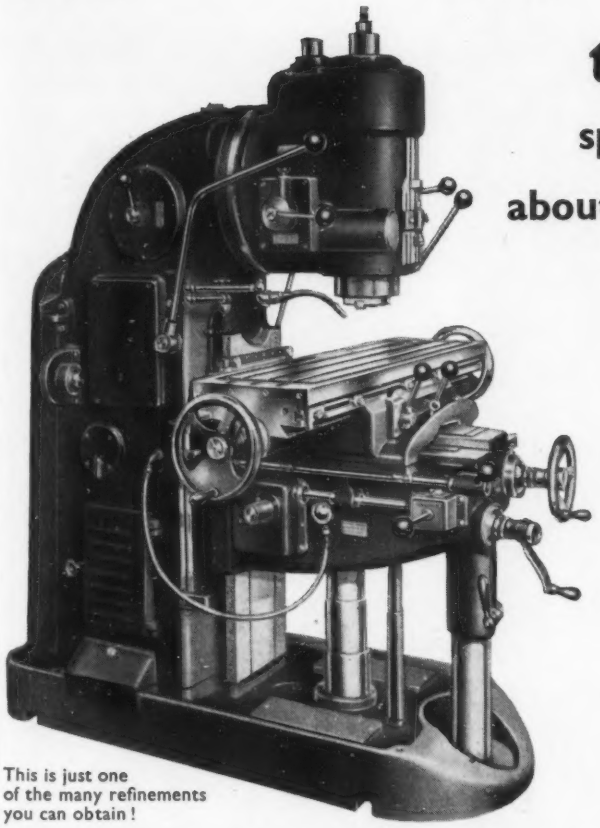

This is just one
of the many refinements
you can obtain!

three men
speak their mind
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A Works Manager says:

Among the many excellent features of VF 1, I want to emphasise the extra support pillar for the knee as well as the spindle enclosure. Besides hand feed, VF 1 has power feed with variable feed pressure and automatic release against an adjustable micrometer stop. The spindle head is moreover swivelling, and can be adjusted accurately. Final judgment. Powerful construction which gives it the precision we want and must have.

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I am naturally especially interested in the practical and well thought out accessories which can be obtained. Take for example the large round feed table with machine feed and dividing plate, or multiple stop for the spindle adjustment, as well as the easily mounted quick milling apparatus. That the machine, by having double-length feed screws, can be used for climb milling makes it doubly valuable.

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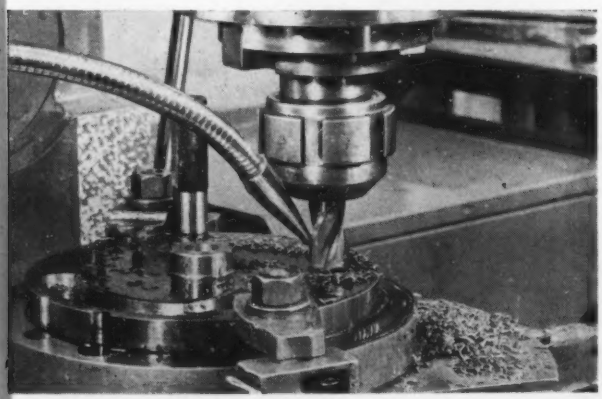
During my years as buyer I have learnt one fundamental thing, which I will readily share. A machine is never better than the service the manufacturer can give. That was also a thing I checked carefully before we decided on VF 1. We were promised perfect service, and practice has also shown that the type of service Köping gives is just right for us on the purchasing side.

Three men with a
common denominator . . .



Curve milling on VF 1 with circular feed
table and power driven circular feed.

KÖPING VF 1

There is so much more we would like to tell you about VF 1. We have a brochure for you packed with valuable and interesting facts about a machine which can be the right one to increase production at your works. Send us a line, and you will receive it by return of post.

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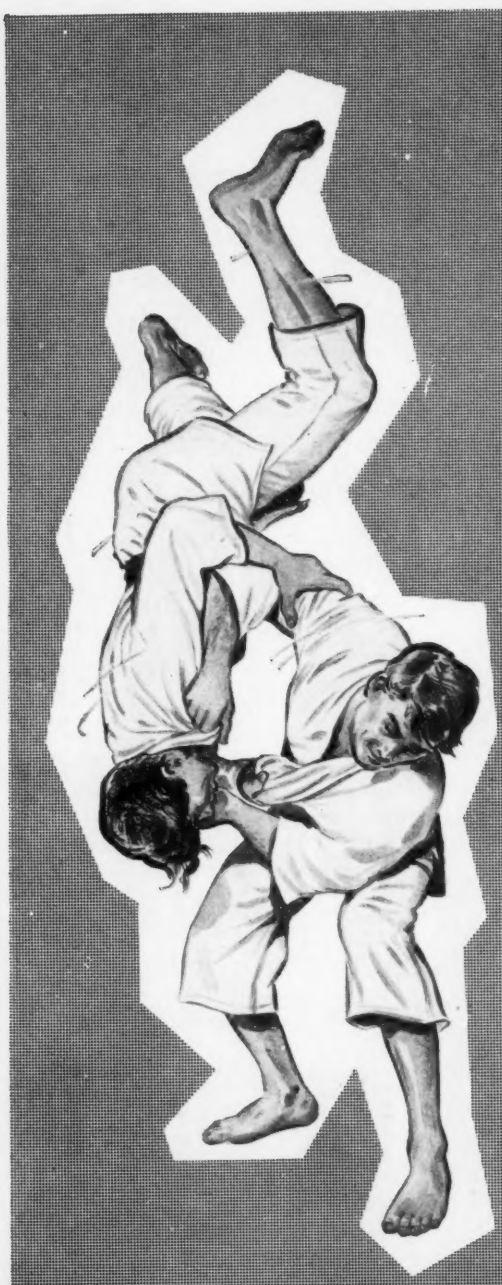

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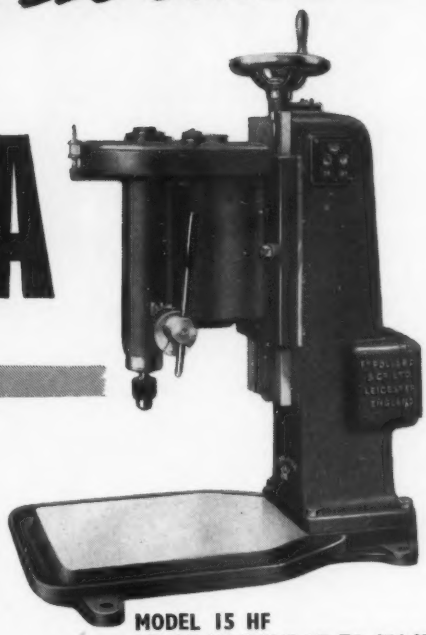
Singleness of purpose and years of experience lie behind any apparently effortless performance.
And so it is with springs.
It's taken for granted that Salter Springs will keep on and on, doing their job with smooth precision — indefinitely.
But it has taken nearly two centuries of skill and devotion to achieve so great a reputation for reliability that—ironically enough—the greatest compliment paid to Salter Springs is that you can forget them!

FOR TOP PERFORMANCE SPECIFY

SALTER

THE **ALL-ACTION** SPRINGS
GEO. SALTER & CO. LTD.
WEST BROMWICH, ENGLAND
Established 1760

SUPER HIGH SPEED DRILLING DEMANDS CORONA



SINGLE OR MULTIPLE SPINDLE MODELS TO SUIT EVERY NEED

- *ADJUSTABLE HEADS*
- *$\frac{5}{16}$in. CAPACITY DRILL CHUCK*
- *8 SPEEDS THROUGH PICK-OFF GEARS*

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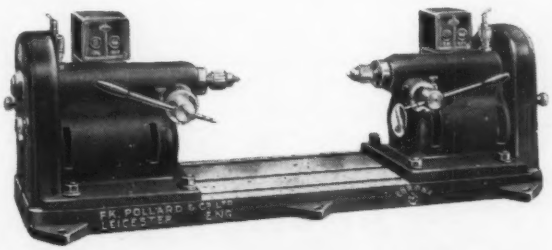
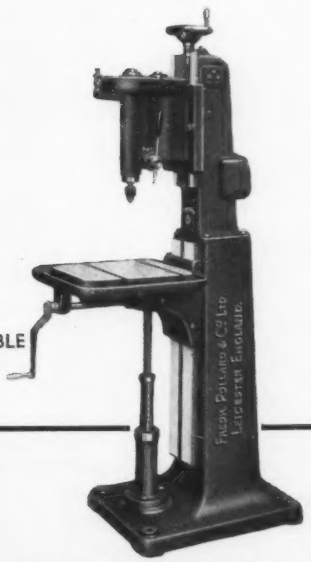
BENCH MACHINE UP TO SIX SPINDLES



MODEL 15 HFHD
DOUBLE END WITH ADJUSTABLE HEADS
CAN BE SUPPLIED WITH COUPLED FEED
ALSO AVAILABLE WITH SINGLE HEAD

MODEL 15 HA
COLUMN MACHINE
WITH ADJUSTABLE TABLE
UP TO SIX SPINDLES



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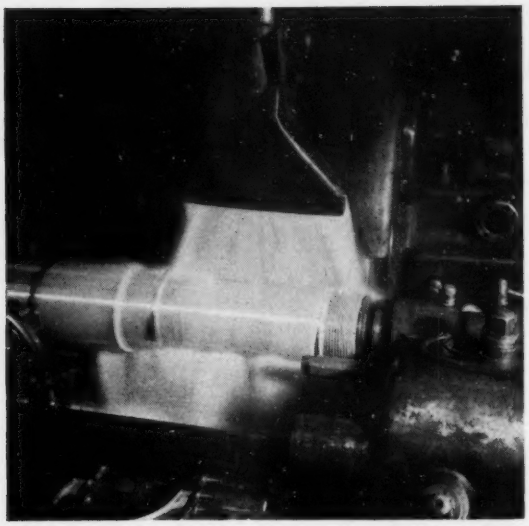

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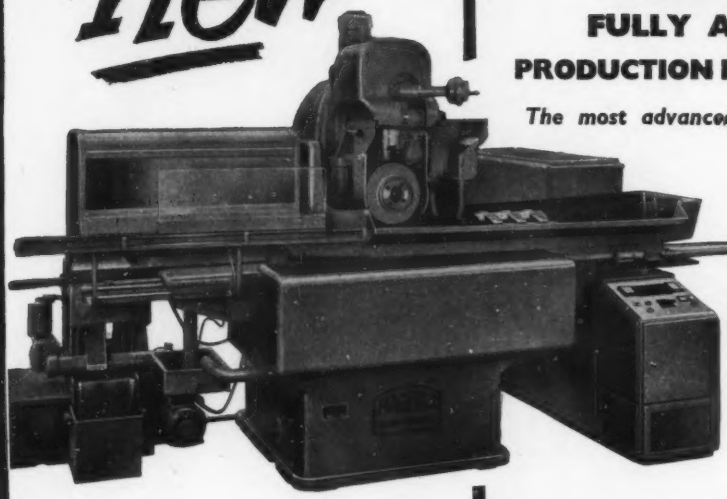

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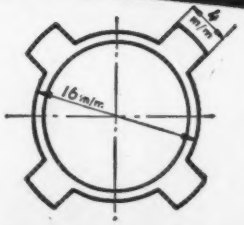

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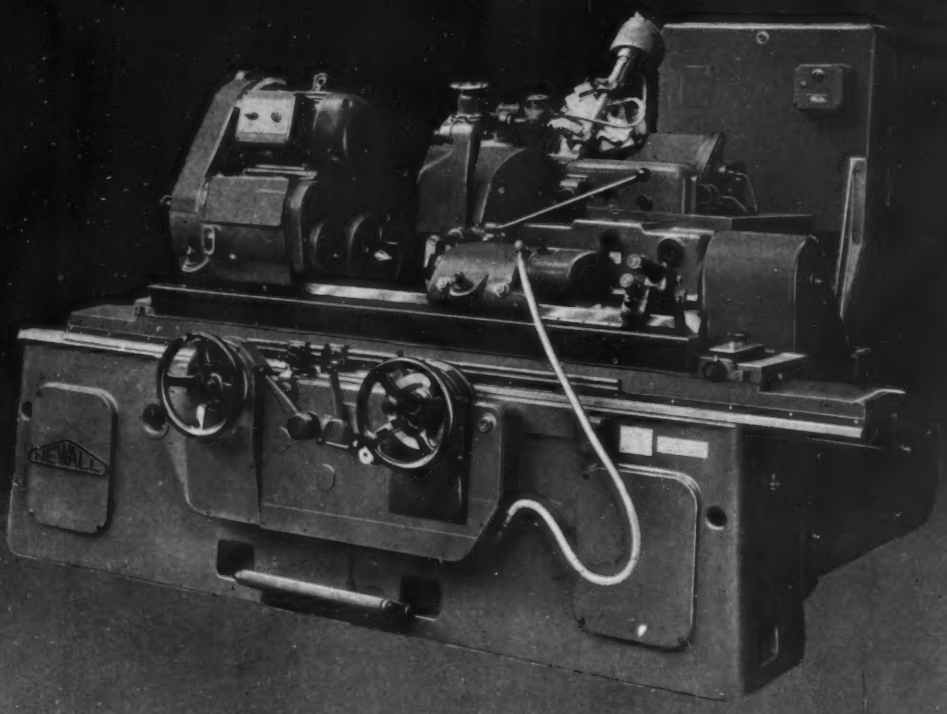

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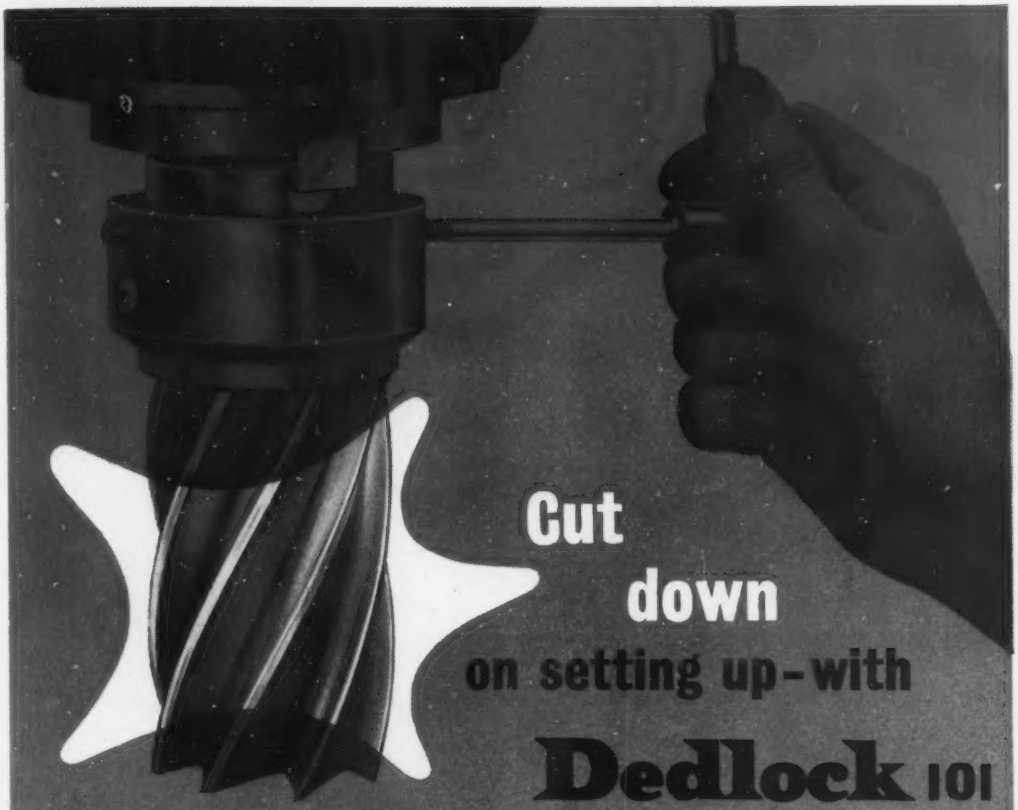

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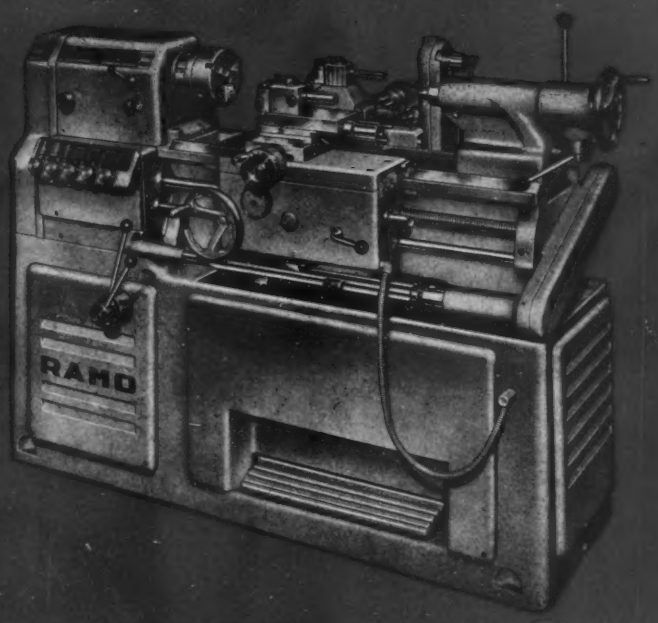

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9 *Test connections*
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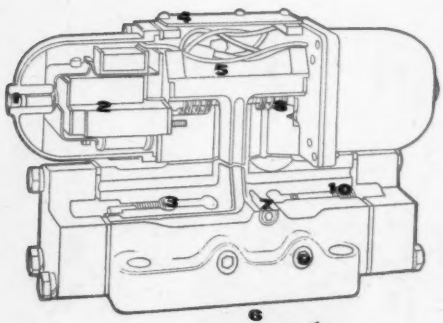

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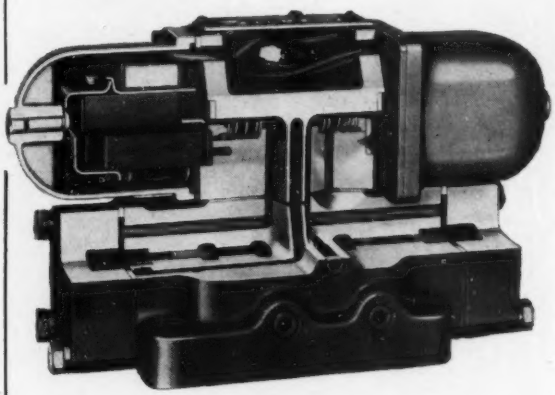

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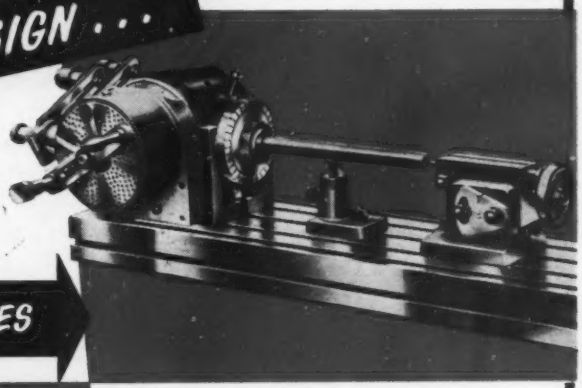

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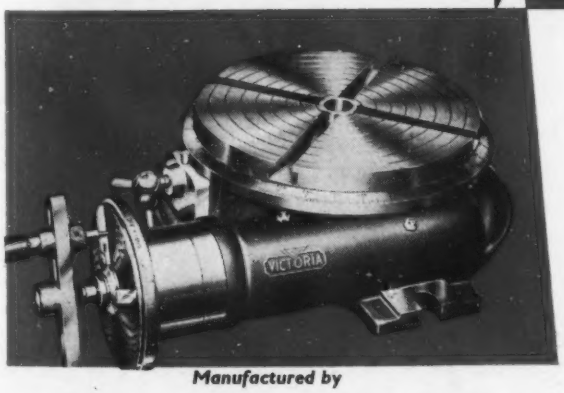

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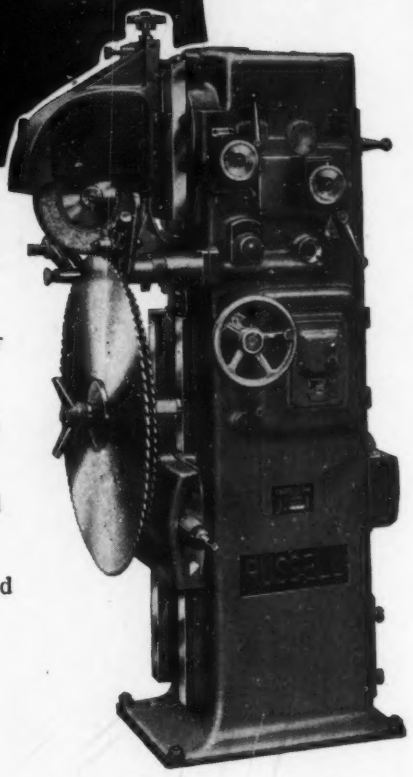

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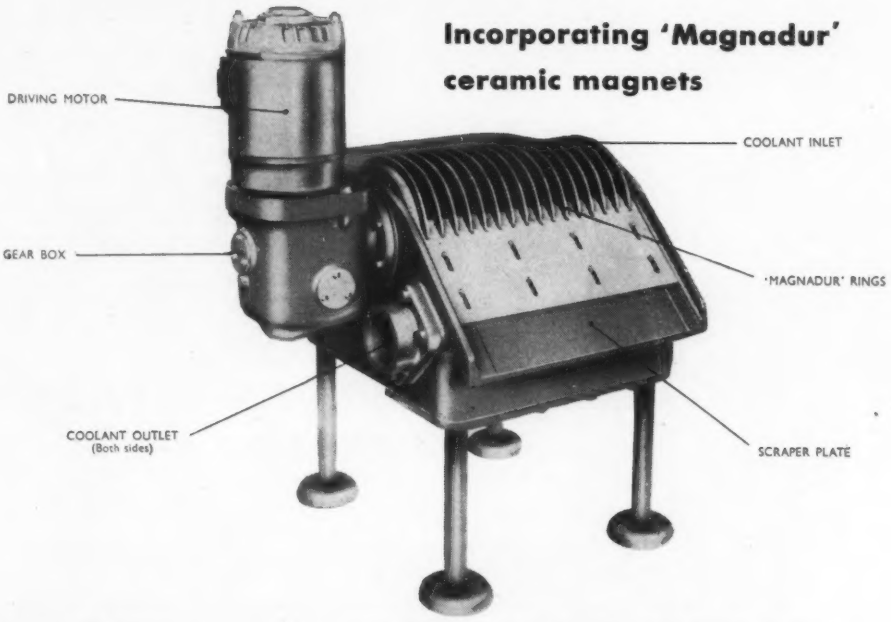

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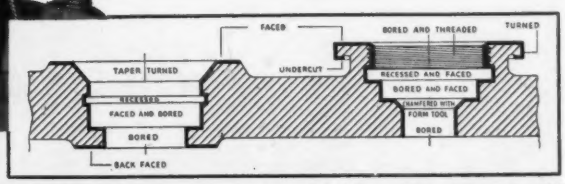

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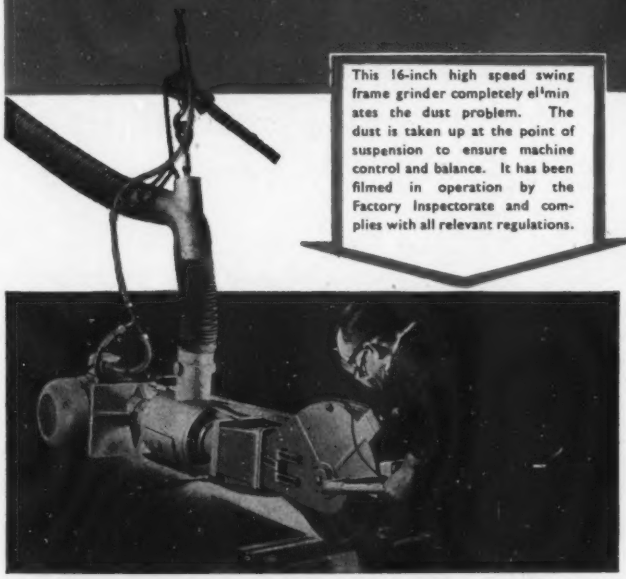

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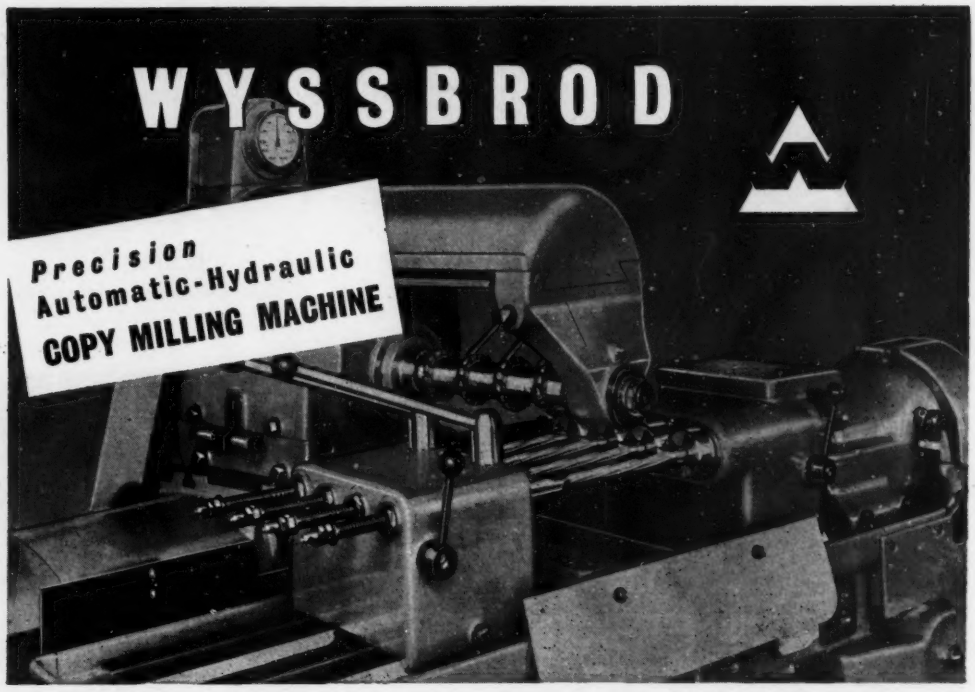

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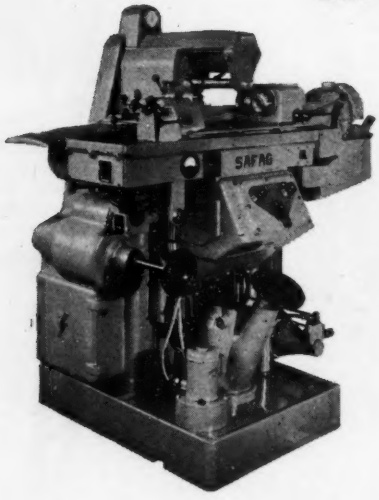

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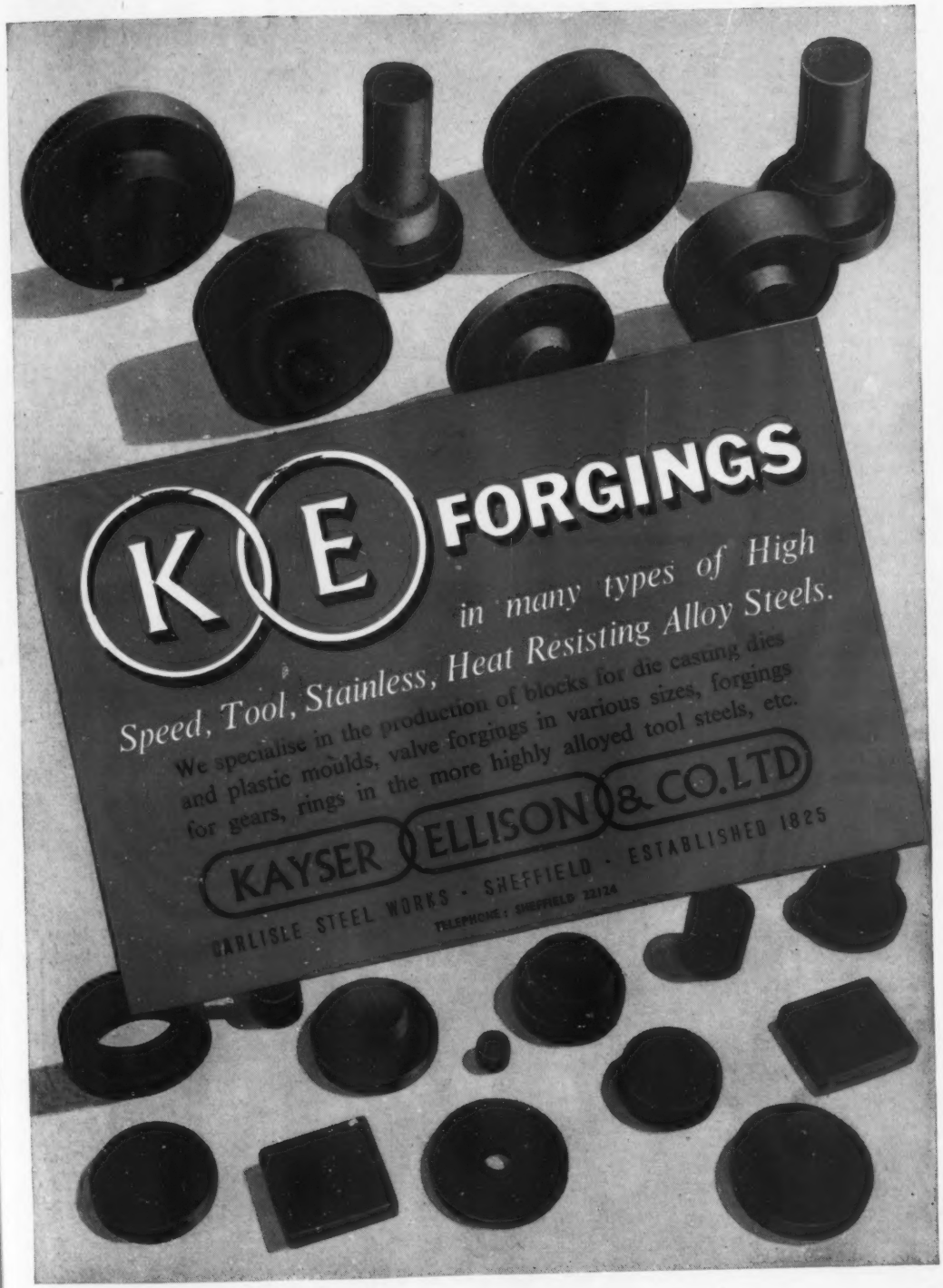
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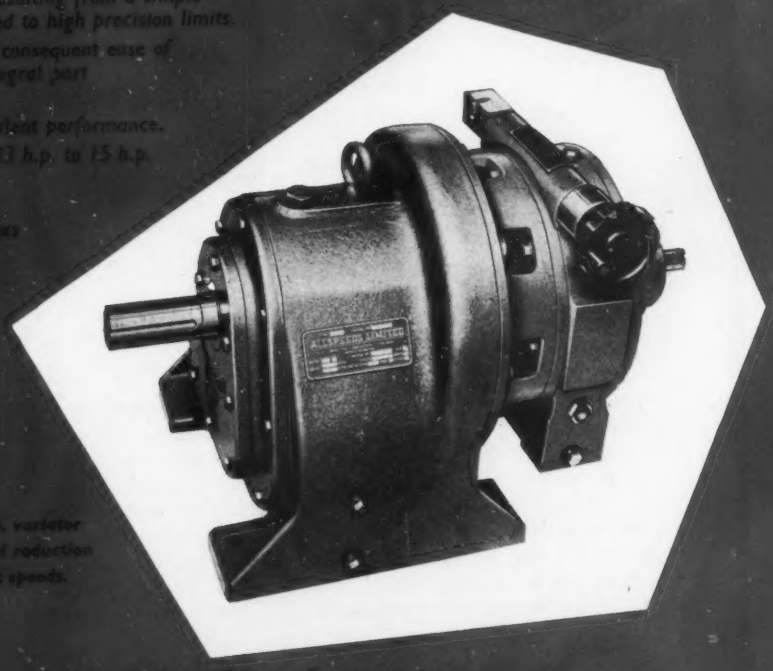

Illustrated is a 2 h.p. variator with flange mounted reduction gear for low output speeds.

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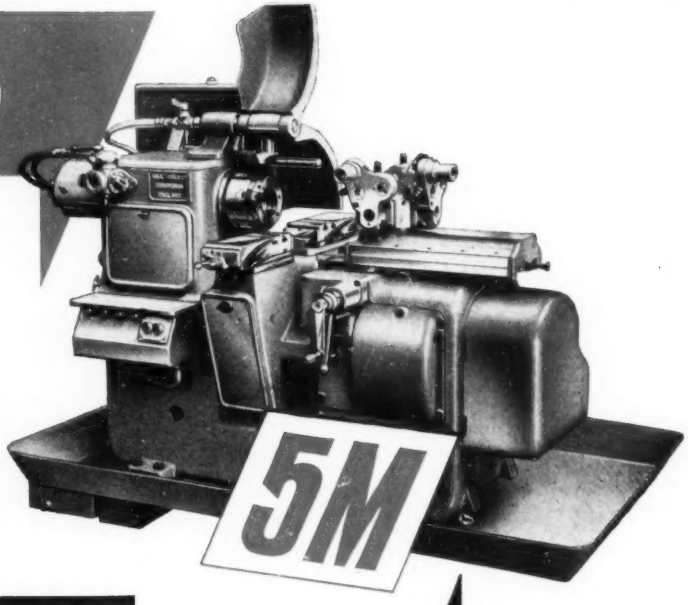

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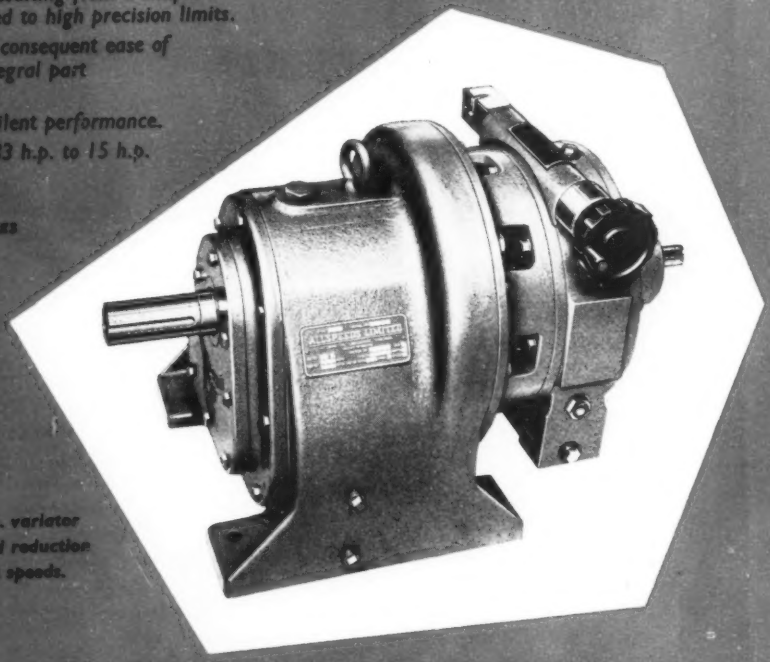

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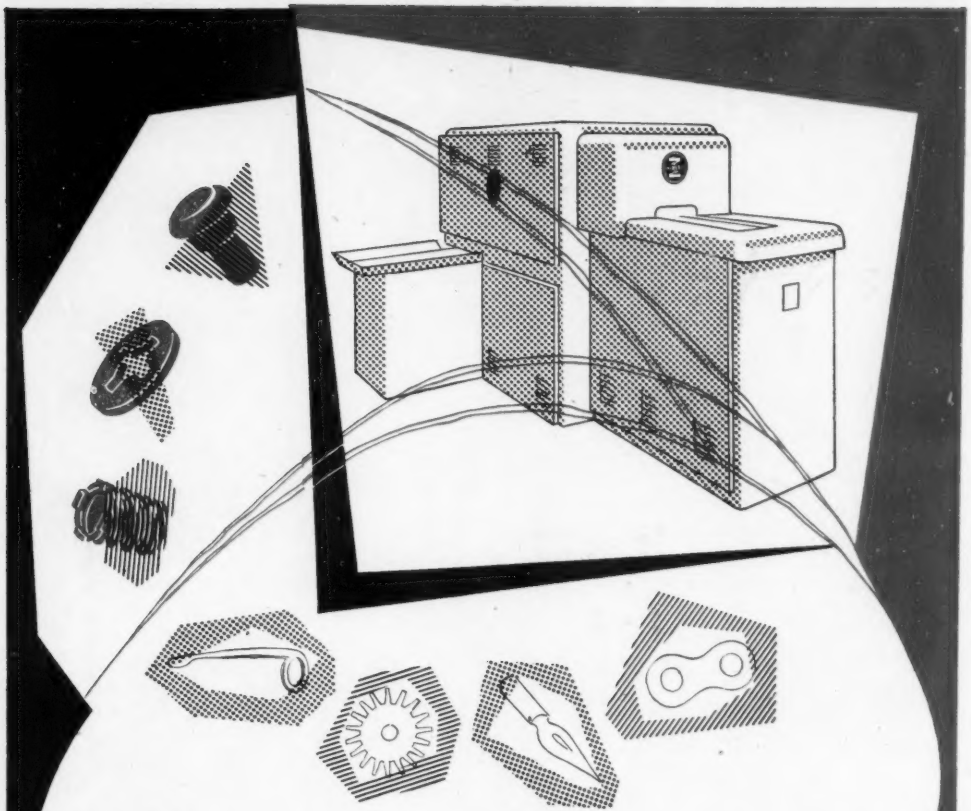

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Abstracts of Principal Articles

The Production of Automatic Transmissions for Motor Cars ..... P. 120

In this second article of a series on the production of the Borg-Warner automatic transmission, operations on the main casing for the unit are described. After preliminary cleaning, the iron castings are milled on the bottom face on a rotary drum-type machine and various holes, including two for subsequent location purposes, are drilled in the bottom face on a 5-station trunnion-type machine. Two further face milling operations on drum-type machines follow, and various bores and holes in the end faces are then machined on a 6-station transfer machine. Angular oil holes are drilled on another special rotary machine, and the castings are then passed to a transfer machine with 10 stations for operations on the side faces. A turn-over unit re-positions the casting on its side before it reaches the last two stations, at which tapping operations are carried out on the bottom face. Grooves in three hydraulic cylinder bores in the sides of the casting are plunge-formed, and an internal boss at one end is faced on a 4-way machine, and two fine-borers are employed to finish the two main-shaft and three hydraulic cylinder bores. Finally, the end faces are fine-turned on a special rotary machine on which the castings are positioned and gripped by expanding diaphrams. (MACHINERY, 93—16/7/58.)

Aspects of Russian Engineering Industry P. 137

In this second article of a series devoted to the Russian engineering industry, some particulars are given of the Ordzonikidze machine-tool plant on the outskirts of Moscow. This plant builds multi-spindle automatics, hydraulic copying lathes, special-purpose machines of various types, and transfer machines. Many of the older machines in the work-shops are of non-Soviet origin, but this equipment is being replaced with new Russian machine tools. Maintenance is carried out on a planned basis, and there is a large department for this work, as well as workshop repair teams. The heat-treatment department is notably efficient, and the production shops are well served with cranes and handling aids. On an average, two transfer machines are completed each month, and about 30 per cent of the output of the plant is exported. (MACHINERY, 93—16/7/58.)

East German Inspection Equipment for Bearing Balls, Races and Camshafts P. 146

This article gives details of the range of fully- and semi-automatic gauging and fine-measuring equipment which is made by VEB Feinmesszeugfabrik Suhl, East Germany, for inspecting bearing balls, races, and camshafts. For grading steel balls according to diameter, three fully-automatic machines are available, covering diameters ranging from 1·5 to 30 mm. (0·060 to 1·181 in.). Line drawings of the principle of operation of each of these machines are given. Machines for preliminary-sorting, and first-stage grading, steel balls are discussed, as is a semi-automatic machine for checking diameter and roundness, which incorporates a Suhl Optikator comparator. A similar comparator is built-in to the instrument which is provided for checking the squareness of the face with the bore of a bearing race. The camshaft checking machine will accept parts up to 40 in. long, and incorporates an electric gauging head and an indicator panel with 48 coloured lights, arranged in two concentric circles. A shaft with 12 cam forms can be checked in 20 min. (MACHINERY, 93—16/7/58.)

Recent Investigations into the Blanking and Piercing of Sheet Materials ..... P. 151

In a paper presented at the Conference on Technology of Engineering Manufacture organized by the Institution of Mechanical Engineers it was pointed out that although blanking and piercing operations have been standard industrial practice for many years, little is yet known of the mechanism of plastic flow and fracture. Recent investigations into some of the factors affecting such operations were described, with particular reference to mechanism of shear, clearance between punch and die, angular shear of cutting edges, and speed of blanking. Attention was then drawn to the possibilities of the so called "finish blanking" process for producing sheared surfaces of good finish on comparatively thick parts. For this process which is applicable to steels as well as non-ferrous metals, a very small clearance is provided between the punch and die and the die mouth has a small polished radius instead of the normal sharp cutting edge. Curves are included to show the effects of die radius on blanking force, dishing, and blank edge taper for certain materials. (MACHINERY, 93—16/7/58.)

Machining Facilities at the Works of Routing, Ltd. .....P. 159

Reference is here made to the works undertaken by Routing, Ltd., a recently established company which specializes in the production of light alloy parts on Wadkin high-speed routing machines. Examples of wing panels and other aircraft components are shown and the methods employed for their production are briefly described. Reference is made to special cutters and an air chuck which are employed for this work. (MACHINERY, 93—16/7/58.)

Contributions to MACHINERY

If you know of a more efficient way of designing a tool, gauge, fixture, or mechanism, machining or forming a metal component, heat treating, plating or enamelling, handling parts or material, building up an assembly, utilizing supplies, or laying out or organizing a department or a factory, send it to the Editor. Short comments upon published articles and letters on subjects concerning the metal-working industries are particularly welcome. Payment will be made for exclusive contributions.

"Productive" Maintenance

Reference has previously been made in MACHINERY to systems for regular maintenance of manufacturing plant of all types with the object of ensuring that unscheduled interruptions are reduced as far as possible. It appears that the need for such schemes is now becoming increasingly recognized, and they are obviously assuming greater importance in view of the rapid advances in automation which are taking place in so many directions. While the general desirability of avoiding all breakdowns remains, it is evident that with the growing integration of production processes, failures of specific items of equipment may have disproportionately serious results by reason of the dislocation of work flow that may ensue.

Clearly, any effective maintenance plan must include provision for stocks of certain spare parts in order that both routine and occasional emergency repairs can be carried out expeditiously. At the same time such stocks must be kept within reasonable limits, on account of the magnitude of the investment that would otherwise be involved, and the storage problems that would arise. In view of these contradictory requirements, it may be necessary in the future for maintenance departments to undertake detailed investigations of the costs that would result from failures of specific items in different circumstances, and to make plans accordingly.

An example—not concerned with metal working—quoted by a leading American company in the electrical field will serve to illustrate this point. In a certain plant, a large electric motor is vital to production, and it has been estimated that the cost of down time is 700 dollars per hour. It has further been estimated that if the armature coils of this motor failed and no major parts were available from stock, there would be an idle period of ten days and the total cost of the failure would exceed 180,000 dollars. If armature coils, costing in the region of 4,500 dollars, were stocked, the idle time would be reduced to six days, but the overall cost of a failure would still be of the order of 111,000 dollars. With a complete armature available from stock, however, a repair could be carried out in seven hours. Such an armature would involve an expenditure of approximately 25,500 dollars, and taking this into account the cost of a motor failure would be about 31,000 dollars. To this figure it would be necessary to add the subsequent cost of repairing the defective armature to serve as a stand-by for the future. The investigation also indicated that the stocking of a complete motor—costing 46,000 dollars—would not be justified since the additional saving in down time and installation expense would be slight.

Given information in this form, it should be possible, in any particular instance, to make a reasonable assessment of the risk of breakdown, and, in the knowledge of what it would involve, to decide whether the provision of certain spares would represent a justifiable insurance outlay. This analysis of breakdown and spares costs represents one aspect of what the organization in question prefers to term "productive maintenance." The plan, as outlined, relates particularly to electrical equipment, although it obviously lends itself to wider application. It does not differ fundamentally from the normal preventive maintenance schemes, but special attention is paid to critical items. There is, of course, nothing new in making particular provision for uninterrupted operation where it is known that serious loss would result from a temporary failure. It is suggested, however, that more systematic determination of relative importance may often be desirable.

In classifying equipment as "critical" or "non-critical," close co-operation between the production and maintenance departments is desirable, and due account must be taken of such factors as percentage utilization, and lack of "by-pass" machines for use in emergency, in order that realistic figures for the cost of idle time may be obtained. When a scheme is first being put into operation, it is necessary, after determining which items are vital to the maintenance of output, to carry out a careful investigation of their condition, possibly with the aid of suppliers' representatives. The advisability of providing spare parts to mitigate the effect of breakdowns can then be considered on the lines already indicated.

Primarily, however, the purpose of productive maintenance is to eliminate unscheduled stoppages by regular attention and replacement of parts which have been found to cause trouble. For the more critical machines, more elaborate schemes of inspection and servicing should be instituted, and detailed records of all operations, failures, and maintenance and operating costs should be kept. In this way it can be ensured that maintenance expenses, which must necessarily continue to rise with more intensive mechanization, are so allocated as to ensure the maximum savings in the cost of idle machine time.

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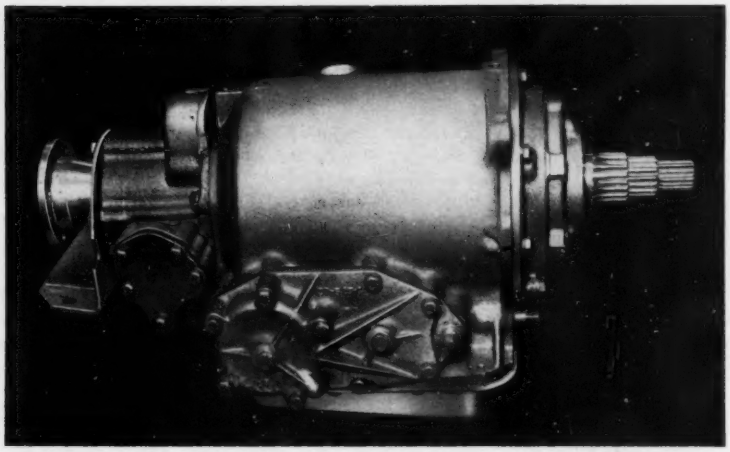
The Production of Automatic Transmissions for Motor Cars



Methods Employed by Borg-Warner, Ltd., Letchworth, Herts.

In an article which was published in MACHINERY, 92/1132—16/5/58, reference was made to the design of the Borg-Warner automatic transmission for motor cars, and to the factory which has recently been erected at Letchworth, Herts, for the quantity production of these units. Operations on the extension casting, which is attached to the rear end of the main case of the transmission (on the car), and serves to house the centrifugal type governor, its hydraulic valve, and the parking pawl with its operating linkage, lever and hydraulic detent, were also described in that article. The rear extension casting is seen on the left-hand end of the assembled unit in the heading illustration, here shown without the hydraulic torque converter, which is supplied separately to the car manufacturer for convenience in installation. In the main casing of the unit, to which the rear extension casting is bolted, are housed the two epicyclic gear units for the intermediate drive ratios, and the manufacture of this casing is here described.

Views of the main casing are shown in Fig. 1, and it may be recalled from the previous article that it houses three hydraulic cylinders, two on the side seen in the heading illustration and one on the other side, which are employed to operate brake bands. These bands are applied to drums within the casing, normally, when the drums are stationary, to select the forward or reverse gear condition, by the automatic operation of hydraulic valves, which control the oil supply to the cylinders. The transmission case is of simple box-shape with bores in its end faces for the mainshaft, bores at the sides for the hydraulic cylinders, and a number of oil passage holes. Some examples of castings in the finish-machined condition, which give an indication of the shape and the amount of machining required, are seen in Fig. 2.

As mentioned in the previous article, most of the plant employed for machining operations on the transmission case, and other components for the mechanical portion of the unit, has been imported from the original factory in the U.S.A., where the unit is no longer in production. This plant includes a number of automatic transfer machines and other interesting units for operations on the transmission case, and is laid out for a production of 65 castings per hour. The castings are supplied by Qualcast, Ltd., in grey iron to B.S.S. 1452, grade 14, with a hardness within the range 170 to 223 Brinell. On arrival at the factory, the castings are subjected to a visual examination and are sample checked for hardness. Thorough cleaning is then carried out by the Kolene (Castingite, Ltd.) process, to which reference was made in the previous article. This process serves to remove all traces of sand or other foreign matter from the cored passages in the castings, which might otherwise become detached in service and enter the hydraulic system.

The first machining operation on the casting provides for rough- and finish-milling the rectangular bottom face, to which the hydraulic

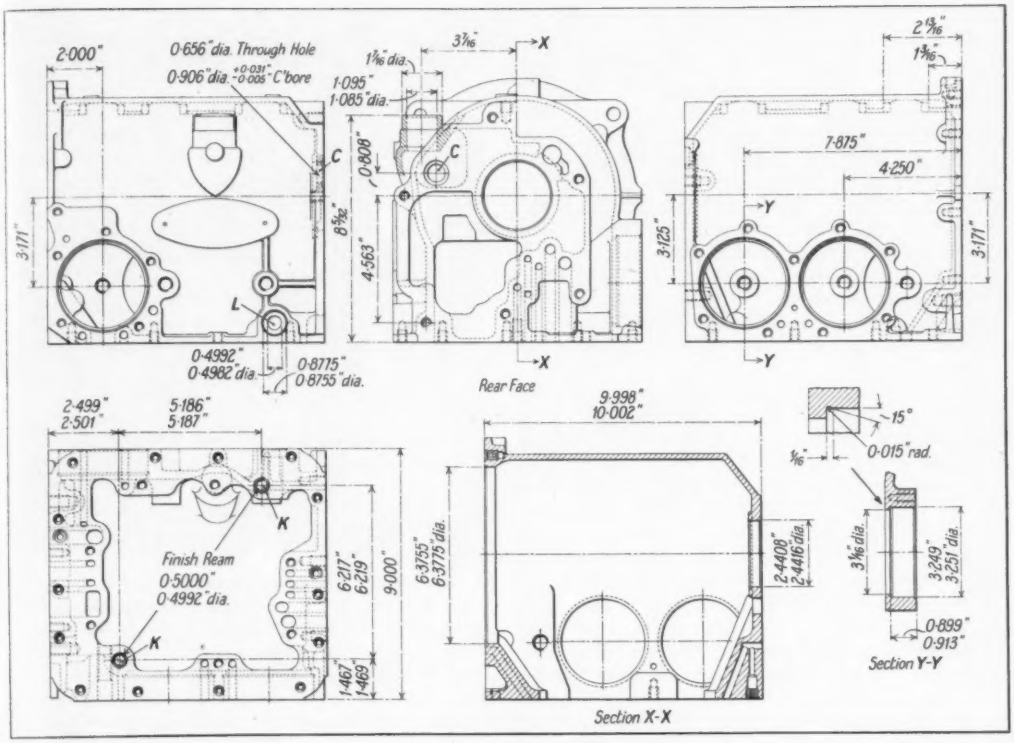


Fig. 1. Views of the Transmission Case for the Borg-Warner Automatic Transmission, with some of the Principal Dimensions. The Two Holes *K* are Provided Solely for Location During Machining Operations

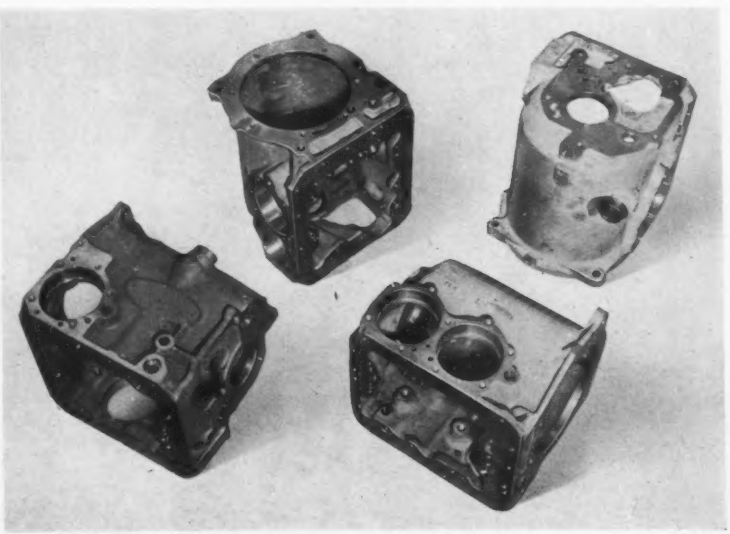


Fig. 2. Four Finish-machined Transmission Case Castings, Showing Some of the Surfaces and Holes Required. Surface Finishes of 50 and 100 Micro-inches are Specified for Certain Bores and Faces

valve assembly and the pressed steel sump are subsequently secured. This operation is performed on a Davis & Thompson Roto-Matic drum-type continuous rotary milling machine, a general view of which is given in Fig. 3. Delivered from the cleaning plant in box pallets, the castings are passed to the milling machine on a double-width roller track, and some castings on this track are seen at the right. Castings are loaded into, and unloaded from, the eight stations on the drum periphery as the latter rotates, and each is secured by four clamps, as will be described. The drum is driven continuously by a 40-h.p. motor mounted on a platform above the machine, and this motor also serves to drive two horizontal spindles in the left-hand column

The speed of rotation of the drum is such that the castings travel at an average speed of 27 in. per min., and they move upwards from the loading position at the front. The upper of the two spindles is fitted with a Wickman Multimill of 12 in. diameter, which has 20 blades of solid Wimet carbide, set at 10 deg. negative rake, and is driven at 88 r.p.m. to give a cutting speed of 277 ft. per min. and a loading of 0·015 in. per tooth. Over most of the area milled, the depth of cut is between ⅛ and $\frac{3}{16}$ in. After passing the roughing cutter, the casting is carried downwards towards the lower cutter, which serves to remove 0·020 in. and to finish the face to within 100 micro-inches, and flat within 0·002 in. total indicator reading. This lower cutter, which is also of 12 in. diameter, has 30 carbide-tipped blades and is driven at the same speed, so that the tooth loading is 0·010 in.

From the finishing cutter, the casting is returned to the loading position, where it is removed from the drum and placed on the end of a curved, inclined roller track, to travel to the next machine in the line, and one end of the track is at the left in Fig. 3. A close-up view of the drum, showing one fixture position empty and another loaded, is given in Fig. 4, and it will be seen that the walls of the box-shaped recess, wherein the casting is accommodated, are provided with projecting pads. These pads serve to locate the casting in three directions, and it is clamped, initially, by means of the hand-screw *A*, which holds it in place while the main clamps are applied. On each side of the box-shaped fixture recess, there are hooked clamps *B*, which are mounted on pins so that they can be swivelled. The inner end of each hooked clamp is connected to a plunger, which passes horizontally through the fixture wall to the further side.

When these plungers are drawn back, from the other side of the fixture, the hooked ends of the clamps are moved inwards, so that they enter cored holes in the end surfaces of the casting. With further withdrawal of the plungers, clamping pressure is then applied to the casting, so that it is pulled back into contact with the locating pads on the rear face of the fixture recess. The mechanism whereby the plungers are withdrawn is seen in the view from the further side of the drum in Fig. 5, where the steel beam to which the plungers are connected is indicated at *C*. This beam is withdrawn, to apply the clamps, by the action of a central

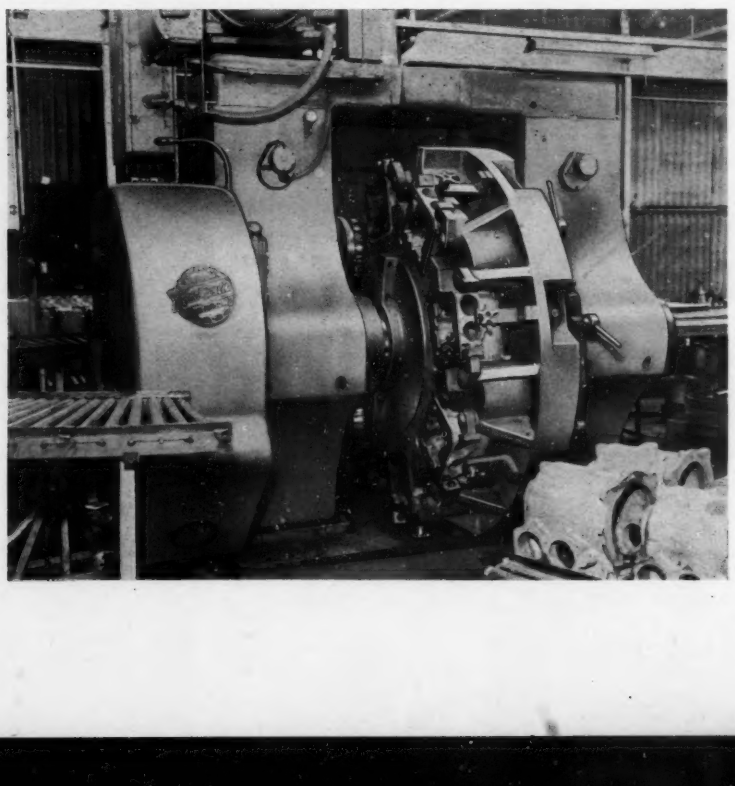


Fig. 3. After the Kolene Cleaning Treatment, the Bottom Cover Face is Rough-and Finish-machined on this Davis & Thompson Roto-Matic Drum-type Continuous Milling Machine

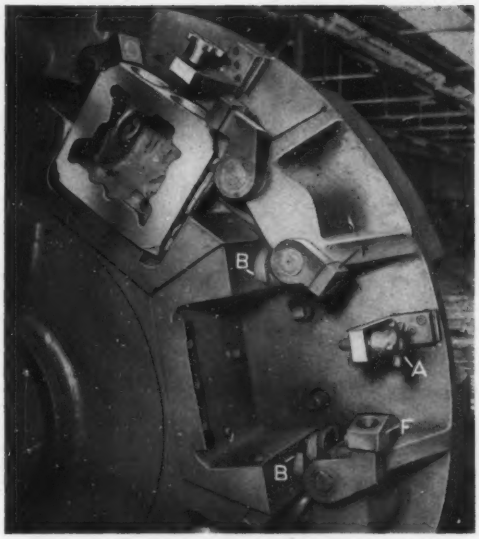


Fig. 4. Close-up View Showing a Loaded and an Empty Fixture Recess on the Roto-Matic Milling Machine, and Details of the Locating and Clamping Arrangements

screw, which engages with a threaded bush in the bridge casting *D*, and is turned by the handle *E*. To the outer ends of the beam *C* are attached further, smaller-diameter plungers, which pass through holes in projections at the ends of the bridge casting *D*. Springs surrounding these plungers serve to advance the beam *C* when the clamping pressure is released, so that the clamp plungers are moved forward to retract the swivelling clamps from the casting.

After the swivelling clamps have been tightened, further pressure is applied at each outer corner of the rectangular casting flange by two more swivelling clamps *F*, Fig. 4, which press the ends of one long edge of the casting against two pads on the corresponding face of the fixture recess. Each of the clamps *F* is secured to the end of a shaft which passes through a bore in a boss near the drum periphery. On the further side of the drum, each shaft carries a short, slotted lever *G*, Fig. 5, and each pair of levers is connected by a short link to a beam. This beam is accommodated beneath the bridge casting *D*, and is connected, near its centre, to a screw which engages with a threaded bush in a depressed portion of the outer rim of the drum. When this screw is turned, by means of a T-handled wrench, the beam is moved further beneath the bridge casting *D*, and turns the shafts carrying the clamps *F*, Fig. 4, until these clamps are in contact with the casting.

Further tightening of the screw applies clamping pressure to the rectangular flange of the casting, and the operator is then free to unload the casting in the next fixture recess. The curved, inclined roller conveyor track, mentioned above, on which the machined castings are placed, leads to the machine illustrated in Fig. 6, the roller track having been purposely extended to act as a buffer storage area for the castings.

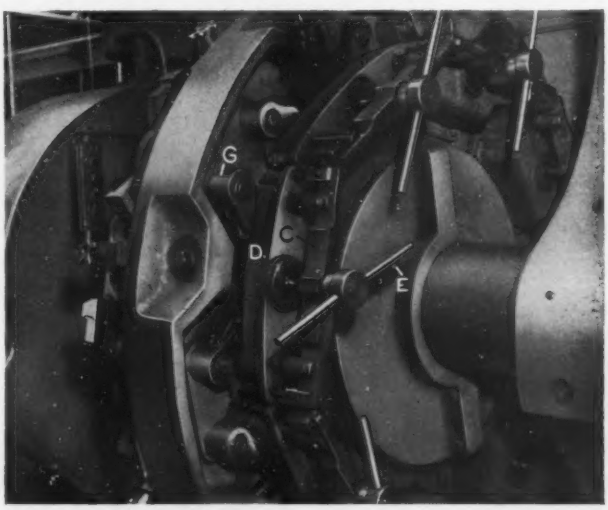


Fig. 5. This View, from the Other Side of the Fixture Drum in Fig. 4, Shows the Mechanism Whereby the Four Clamps which Secure the Casting are Tightened

BAUSH TRUNNION-TYPE DRILLING MACHINE

Employed for drilling, reaming, spot-facing and counter-sinking operations on the machined bottom face and the curved top portion of the casting, the Baush machine shown in Fig. 6 has a central drum which is supported on trunnions in bearings in a heavy ribbed casting at each side. The drum has a holding fixture on each of its five faces, and loading is carried out at the front station.

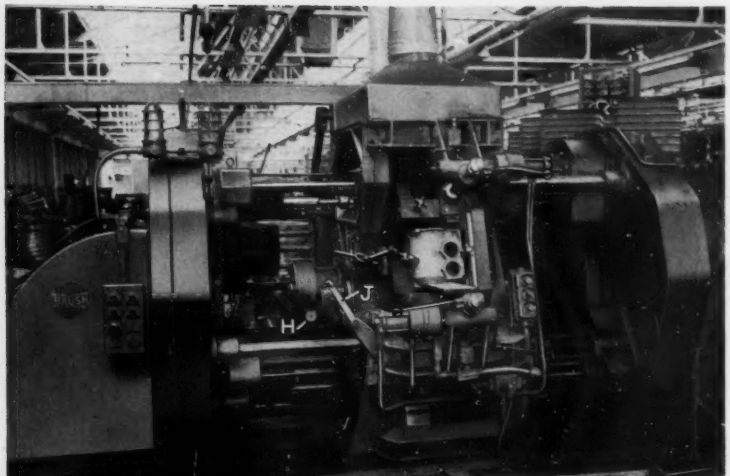


Fig. 6. General View of the Baush 5-station Trunnion-type Machine for Drilling, Reaming, Spot-facing and Counter sinking Operations on the Bottom and Curved Top Faces of the Casting

Indexing of the drum is effected by means of a horizontal hydraulic cylinder at the left, the ram of which is connected to a rack. The end of this rack is indicated at *H*, and it meshes with a pinion on the end of the drum trunnion at that side, the drive being transmitted through a free-wheel to provide for retraction of the cylinder ram. Angular location of the drum, during the machining operations, is obtained by means of a plunger which is moved axially by a lever *J*, connected to a horizontal shaft. Cams on this shaft actuate limit switches, as it is turned, to control solenoid valves which change the direction of the oil supply to the indexing cylinder, and to complete electrical circuits which permit the automatic machine cycle to be started. When the indexing plunger is in the advanced position, the cycle is initiated by pressure on a button at the right of the loading station.

The casting is loaded with the machined bottom face in a vertical position at the right, and most of the operations are performed on this face. When the drum is indexed, the freshly-loaded component is carried upwards, through an angle of 72 deg., to the first machining position, and multi-spindle heads on ways at each side of the central drum are moved inwards hydraulically. With the right-hand head at this first station, 15 holes of 0·257 in. diameter are drilled in the flange, for subsequent tapping $\frac{5}{16}$-in. by 18 N.C.2, for the attachment of the cover and the hydraulic valve assembly. At the same time, one 0·257-in. diameter hole is drilled and counterbored with a combination tool, and another hole, of ¼ in. diameter, is drilled. The left-hand head at this position has three spindles, which provide for drilling two holes of $\frac{5}{16}$ in. diameter, for subsequent tapping ⅜-in. by 16 N.C.2, and drilling a 1·085-in. diameter hole in the oil-filler boss.

At the second machining position, at the rear of the machine, there are 10 spindles in the right-hand head, for drilling holes ranging from ¼ in. to $\frac{13}{32}$ in. diameter, including the two holes *K*, Fig. 2, which are employed solely for locating the castings during subsequent operations. The left-hand head at this position carries a single spindle, which is fitted with a hollow milling cutter for reducing the outside diameter of the oil-filler boss to $1\frac{7}{16}$ in. over a distance of ½ in. Six spindles at the right-hand side at station three, are employed to drill one more 0·257-in. and two more ¼-in. diameter holes; to combination-ream and chamfer the two locating holes *K*, Fig. 2, to $\frac{15}{32}$ in. diameter; and to counter-bore a 0·257 in. diameter hole. There is no left-hand head at this position.

At the final machining station, there are 15 spindles at the right-hand side, of which 11 are employed for counter-boring various holes in readiness for tapping, and two for drilling ¼-in. diameter holes. At the same time, the two locating holes are finish reamed to 0·4992/0·5000 in. diameter with carbide-tipped reamers. Three spindles on the left-hand head provide for countersinking the two holes previously drilled in the curved face of the casting, in readiness for tapping, and for spot-facing the oil-filler boss. The casting is then returned to the loading station, for removal. Cutting speeds of the order of 50 ft. per min. are

employed on this machine, and, for the majority of the drilling operations, the feed is approximately 0·010 in. per rev.

LOADING OPERATIONS

A close-up view of the loading position is given in Fig. 7, and it will be seen that a horizontal platform is provided to support the casting before it is pushed into the fixture recess. In the recess the casting rests on its left-hand side (as installed in the car) on three pads. After placing the casting in position, a toggle-clamp, mounted on the side of the left-hand trunnion support casting, is applied to the curved top surface to hold the bottom face against four pads at the right of the fixture recess. In this position, the casting rests with one of the projecting ears *L*, at the top of the front face, adjacent to a stop within the recess, which provides end-wise location.

Opposite this stop, above the ear *L*, there is a screw-clamp, which is next turned by means of the star-wheel *M* so that it is advanced into contact with the front face of the casting to press the ear against the stop. A second star-wheel *N* is now screwed down, to hold the casting in position while the main clamps are applied to the mainshaft bores at each end, so that the bottom face is thrust into contact with the four pads at the right. These main clamps are located above and below the position occupied by the casting, and they can be moved inwards by means of pegs, so that they enter the mainshaft bore. These pegs are held in the cylindrical portions of cams which are carried on shafts above and below the fixture recess. After the clamps have been advanced into position, the cams are turned further and the outer ends of the clamps are raised.

Pressure is thus applied so that the inner ends of the clamps, which are pivoted near their centres, are moved into contact with the mainshaft bores, with the result that the bottom face of the casting is thrust to the right into contact with the four pads mentioned above. To avoid operator fatigue, hydraulic power is employed for the clamping operation, a separate cylinder being provided for each cam. The outer end of the shaft carrying the upper cam is seen at *P*, and that of the lower cam at *R*, Fig. 7, and each shaft terminates in a flat end surface with a hexagon head at the centre. The mechanism for turning each camshaft is similar, and reference will here be made to each, as convenient. Brackets above and below the position at which loading takes place carry horizontal hydraulic cylinders, as seen at *S*, and the oil supply to these cylinders is controlled by the valve *T*. To the end of each cylinder ram is connected a rack, the teeth of which mesh with a pinion on a sleeve with a hexagon bore.

The axis of this bore is aligned with the shaft of the clamping cam and it contains a plunger *U*, also of hexagon form, with a mushroom head at the outer end, and a hexagon socket at the inner end. This hexagon socket fits the hexagon head at the

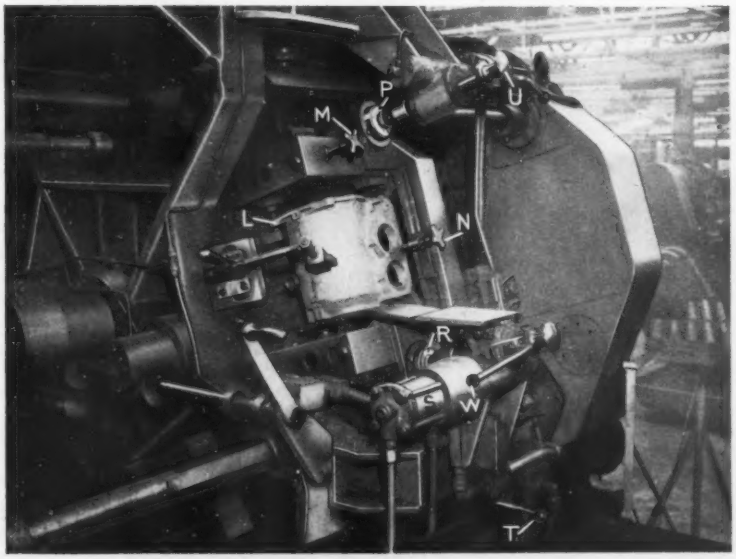


Fig. 7. Details of the Locating and Clamping Arrangements on the Baush Trunnion-type Machine may here be seen. The Casting is Temporarily Held in Place by a Toggle Clamp while Other Clamps are Applied

end of the camshaft, and the plunger can be advanced by hand to bring socket and head into engagement.

Next, the valve *T* is operated to turn the sleeve, and consequently the camshaft, in either direction, as required. It will be observed that part of the end face of the shaft is painted white, to correspond with the position of the cam, so that the operator can judge whether it is the resistance offered by the clamp, or the fact that the ram has reached the end of its stroke, which is preventing further rotation of the shaft.

Should the length of the ram stroke be insufficient to turn the cam to the clamping position, the socket is disengaged from the haxagon head by means of the lever *W*, the ram is retracted by operating the valve *T*, and the procedure is repeated to complete the tightening of the clamp. Then, the lever *W* is again employed to retract the socket from the hexagon head, against the torque applied by the hydraulic cylinder, and a similar sequence is carried out for tightening the other clamp. When each plunger is advanced, a limit switch within the support bracket is operated to isolate the indexing circuit, so that the drum cannot be turned if either socket is engaged. When loading, which is carried out during the machine cycle, has been completed, and the spindle heads have withdrawn, the operator disengages the locating plunger by means of the lever *J*, Fig. 6, and presses the indexing button. The drum is then turned through 72 deg. to the next position and when the lever *J* has been returned to engage the locating plunger, also the cycle-start button has been pressed, the heads move in. Unclamping and removal of the machined casting is then carried out by a reversal of the loading procedure.

MILLING THE END AND SIDE FACES

From the Baush machine, the castings are transferred, on lengths of roller track, to two more Davis & Thompson Roto-Matic rotary milling machines, on which the front and rear and the side faces are rough- and finish-machined, in succession. The machine for the first of these operations, on the front and rear end faces, is shown in Fig. 8, and is of similar design to that described earlier, except that it has four spindles, two on each side of the central drum. These spindles are fitted with 12-in. diameter facing cutters, each having 30 inserted, tungsten carbide blades, which serve to rough- and semi-finish-machine the end faces, leaving 0·017 in. of material on each face for a final operation. Loading is carried out while the drum is rotating, the casting being placed with its machined bottom face towards the drum surface and located by dowels which engage the two holes *K*, Fig. 2.

A hinged clamping arm carrying a central, triangular, universally-mounted pressure pad, is then swung down over the casting, and the slot in one end is engaged with a swivelling eye-bolt. A nut on the end of this bolt is then tightened with a spanner to secure the casting in position. While the finished casting is being removed and the fixture re-loaded, the clamping arm is held in the raised position, clear of the casting, by means of a heavy-duty ball catch housed in one of the inner faces of the grooved member in which the arm is pivoted. On the third Roto-Matic machine, which is similar to that shown in Fig. 8, the castings are again loaded on their bottom faces and located by the dowel holes, but in a position at 90 deg. to that shown, so that the side faces are presented to the cutters. Simple lever-type clamps are used.

Four facing cutters, of 8 in. diameter, each with 20 inserted carbide blades are employed for the side faces. On both machines, the cutters are run at a surface speed of about

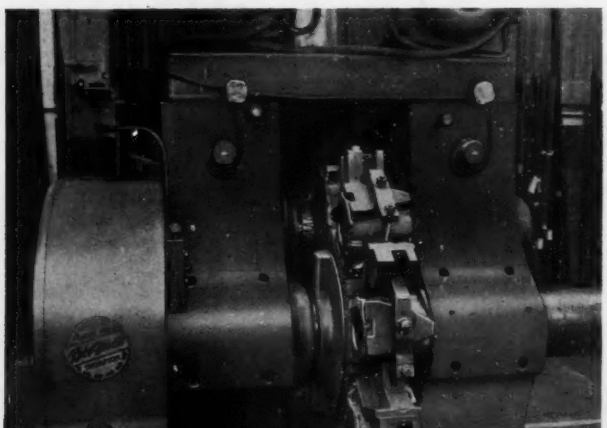


Fig. 8. Two Similar Davis & Thompson Roto-Matic Drum-type Milling Machines are Employed for Machining the Front and Rear, and Side Surfaces of the Casting

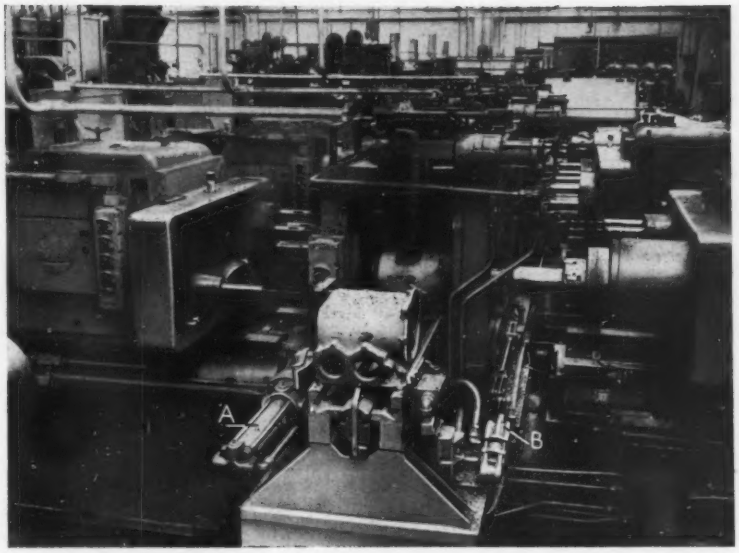


Fig. 9. On this Baush 6-station In-line Transfer Machine, Operations are Performed on the Front and Rear Faces of the Casting, Including Rough- and Semi-finish Boring the Mainshaft Holes

275 ft. per min., and the drum rotation provides feed rates of 27 and 20 in. per min. for end and side faces, respectively. The cutters originally employed on the machines were of American origin. It was found, however, they could satisfactorily be replaced by Wickman Multimills, with solid carbide inserted blades which are easily reground. A finish within 100 micro-inches, and flatness within 0·002 in. total indicator reading, are specified for all the finished-milled surfaces of the casting, and to achieve these results it has been found that the cutters must run true within 0·0004 in.

BAUSH IN-LINE AND ROTARY TRANSFER MACHINES

After the completion of the milling and other operations described, the castings arrive at the first of three Baush transfer machines. A general view of the loading end of this 6-station machine is given in Fig. 9, and it may be noted that it is constructed in three sections, each comprising two stations. Each section has its own transfer bar, operated by a long-stroke hydraulic cylinder, as seen at *A*, and fitted with spring-loaded fingers for the movement of the castings between the machining stations. The castings are loaded with their front faces to the right and rest on their bottom cover faces, on the transfer track. At each station, the casting is located by means of two plungers, which are raised, to enter the holes *K* Fig. 1, by means of a short-stroke hydraulic cylinder at the right, as seen at *B*, the motion being transmitted through linkages and cam mechanisms. Separate plungers and operating mechanisms are provided for each of the three sections of the machine.

At each station, the castings are clamped at their ends by beams, fitted with equalizing pressure plates. These beams are lowered by cams on shafts which are turned by hydraulic cylinders, mounted on bridges supported by the bush plates at each side of the transfer track, and acting through racks and pinions. All the movements of the locating and clamping mechanisms, and of the machining heads, are interlinked electrically, to ensure the correct sequence. Operations performed on this machine are concerned only with the front and rear faces, and at the first machining position, the head at the right-hand side of the machine is equipped with a heavy boring bar, fitted with two multi-blade boring tools. Each tool has a total of eight blades, of which four are set in advance for rough-machining the bore, while the others serve for semi-finishing. The diameters produced by the two cutters are 0·025 in. smaller than those specified in the drawing, Fig. 1, to allow for subsequent finish-boring operations, and the surface speed for the larger bore is 200 ft. per min., and the feed, 0·006 in. per rev.

At the left-hand side of the first machining station, there is a single spindle for drilling a $\frac{7}{16}$-in. hole in the rear face of the casting, for an oil transfer port. The head on the right at station (2) carries five spindles, of which two drill $\frac{15}{32}$-in. holes in the ears at the top of the front face, one drills a ½-in. hole for an oil port, and the remainder drill two tapping-size holes (for $\frac{7}{16}$-in. by 14 N.C.3). At this station, the left-hand head, which is equipped with seven spindles, drills oil ports and other holes, ranging from ¼ to $\frac{7}{16}$ in.

diameter, in the rear face. The casting is then transferred to an idle position between the first and second sections of the machine, and thence to station (3), where an 8-spindle head at the right provides for drilling the seven 0·257-in. mounting holes for the torque converter housing in the front face, and one oil port of ¼ in. diameter. Of the five left-hand spindles at this position, one is employed to drill and counter-bore the hole *C*, Fig. 1, to diameters of 0·656 and 0·906 in., and the other four to drill holes ranging from $\frac{5}{16}$ to $\frac{11}{16}$ in. diameter.

Six spindles in the right-hand head at station (4) drill holes from ¼ to $\frac{3}{8}$ in. diameter in the front face, and seven spindles in the left-hand head are employed to drill one ¼-in. hole, and countersink $\frac{7}{16}$-in. holes, which have previously been drilled, in readiness for tapping. There is another idle position between the second and third sections of the machine, and the castings then pass to station (5), which is employed for tapping. The right-hand head carries seven taps ($\frac{7}{16}$ in. by 18 N.C.2) for the torque converter mounting holes, and the left-hand head, six taps ($\frac{3}{8}$ in. by 16 N.C.2) for the mounting bolts which hold the rear extension casting in place, as described in the previous article. All the taps are held in standard Baush holders and are lubricated by paraffin spray. At station (6) there is a right-hand head only, which is equipped with $\frac{7}{16}$ in. by 14 N.C.3 taps, for two other holes in the front face. Low spindle speeds and feed rates are employed on this and the other Baush transfer machines to be described, drilling being performed at about 40 ft. per min. with feeds of the order of 0·006/0·008 in. per rev., and it is stated that very long tool life is obtained.

After they have been unloaded from the farther end of the machine in Fig. 9, the castings are moved, on a short length of roller track, to the Baush, 6-station, rotary transfer machine shown in Fig. 10, which is employed for drilling the eight angular oil transfer holes. These holes have diameters of ¼, $\frac{7}{16}$ and ½ in., and they are drilled by means of spindle heads which are mounted at the required angles of 22 and 35 deg. to the vertical bottom face of the casting, at each of the fixture positions. The circular table is indexed in an anti-clockwise direction, as viewed from above, by a mechanism similar to that employed on the machine in Fig. 6, the lever for the disengagement of the locating plunger being seen at *D*. The six fixtures are arranged near the edges of the table, and each has a vertical face on the side nearest to the table centre, against which the casting is clamped.

Loading is carried out at the position seen at the front in Fig. 10, and the casting is placed in the fixture with the front face towards the left, so that the side with only a single hydraulic brake cylinder is facing upwards. The spring-loaded dowels, retractable by means of a lever *E*, at the base of the fixture, locate the casting, and it is secured by means of two clamps, one at each side. The action of these clamps can be more clearly described with reference to Fig. 11, which shows a close-up view of one of the fixtures. There are two horizontally-moving clamps, which enter the mainshaft bores at the ends of the casting when they are in the advanced position, this arrangement, also, being similar to that on the machine in Fig. 6, except that the clamps are hand-operated. The end of one clamp, in the retracted position, is just visible at *F* in Fig. 11, adjacent to a cam *G*.

This cam is keyed to a vertical shaft which can be turned by a lever *H*, and it has a cylin-

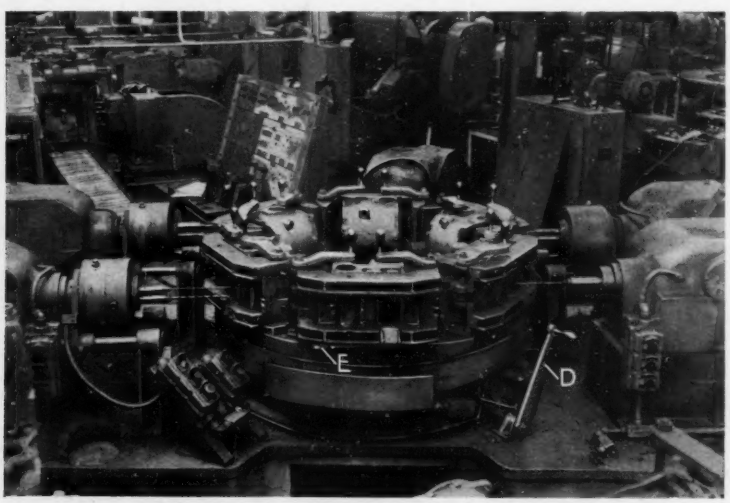


Fig. 10. All the Angular Oil Holes, which are Drilled at Angles of 22 and 35 deg. to the Bottom Face, are Machined on this Baush 6-station Rotary Transfer Machine

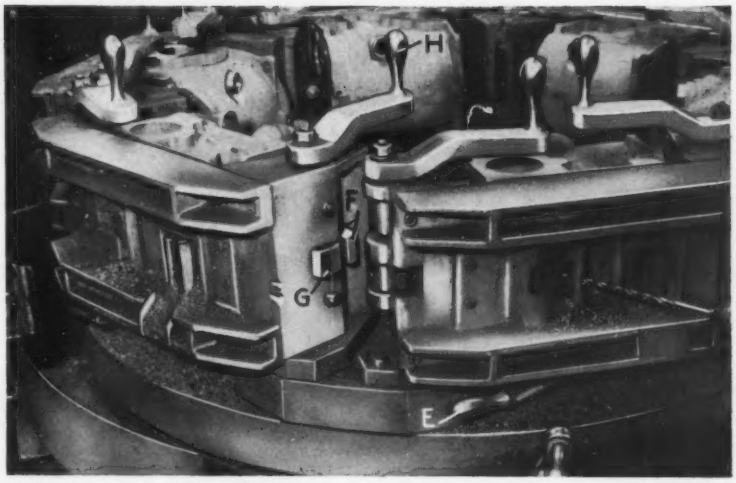


Fig. 11. In this Close-up View of the Baush Rotary Transfer Machine, Details of the Clamping Arrangement for the Castings may be seen. Spring-loaded Locating Dowels are Retracted, for Unloading, by a Lever *E*

drical portion with a peg. There is a slot in the clamp, and when the shaft is turned by the lever, the peg enters the slot and advances the clamp into the main-shaft bore of the casting. With further rotation of the cam, an eccentric portion engages the clamp, moving one end towards the table centre and causing the other end to press the casting hard against the vertical face of the fixture. These arrangements are duplicated at the other end of the fixture and are very straightforward in operation. Inspection of the drilled castings is carried out with the aid of a torch and a hole template, which is laid over the bottom face so that it obscures all but the angular holes. Light from the torch is directed towards the end faces of the casting, and the angular holes are inspected to ensure that they communicate with the holes in these faces.

The loading station of the second Baush in-line transfer machine is adjacent to the position at which the castings are unloaded from the rotary machine, and may be seen in Fig. 12, where part of the rotary machine is visible in the foreground. Transfer, locating, and clamping arrangements are somewhat similar to those employed on the first Baush machine, and the casting is loaded on its bottom face with the rear end leading, as seen at *J*. The machine is again divided into sections, each with two machining stations, and there are ten stations, of which eight are employed for operations on the side faces, including boring the hydraulic cylinders for the brake bands. Before it passes to the two final stations, the casting is automatically turned on its side, in order that holes in the bottom face can be tapped.

At the first station to which the casting is transferred, there are three spindles at the right-hand side, and it may be noted that these operate on the side of the casting which is to the left (facing the front) when installed in the car. The larger of these spindles is equipped with a cutter having four inserted blades, which rough-machines the single, cored, hydraulic cylinder bore on that side of the casting. The bore is roughed to a diameter approximately 0·075 in. smaller, and to a depth of about 0·030 in. less, than the dimensions quoted on the drawing, Fig. 1. A $\frac{13}{16}$-in. hole is drilled in the position *L*, Fig. 1, by a tool in one of the other spindles, and a dimple is formed by a tool in the third spindle in a position at which another hole is later drilled. The left-hand head at this position has two spindles fitted with 4-bladed cutters similar to that on the right, for rough-boring the twin hydraulic cylinders to the same dimensions as indicated above.

Single-point tools are employed in one spindle on each side at station (2), for semi-finish boring the single cylinder bore on one side, and the bore nearest the front end (in the car) on the other. These tools are set to leave about 0·025 in. on the diameter of each bore for a final operation, and to bring the bores to the specified depth of 0·899/0·913 in. An additional spindle, in the right-hand head, drills the stepped hole *L*, Fig. 1, which accommodates a hydraulic control valve spindle in the assembled unit. There is an idle position between the first and second sections of the machine, and at station (3) there are five spindles at the right- and four at the left-hand side. These spindles serve to drill holes ranging from $\frac{1}{4}$ to $\frac{17}{32}$ in. diameter in the side faces of the casting, including holes in line with the axes of the three hydraulic cylinders, which will accommodate adjusting screws for the brake bands.

At the right-hand side at station (4) there are six spindles, one of which is equipped with a stepped tool to semi-finish ream the hole *L*, Fig. 1, to diameters approximately 0·015 in. smaller than those specified. The other five spindles drill holes of ¼ to $\frac{21}{64}$ in. diameter. Of two spindles in the left-hand head at this position, one carries a single-point tool to semi-finish bore the third hydraulic cylinder, and the other is employed to drill a $\frac{21}{64}$-in. diameter hole. Another idle position follows, and the casting then passes to station (5), where the right-hand head has five, and the left-hand head eight, spindles for drilling holes from ¼ to 0·257 in. diameter. There are 11 holes of the larger size, which are later tapped $\frac{5}{16}$ in. by 18 N.C. 2 for the attachment bolts for the cylinder covers. Heads on both sides at station (6) are employed to countersink most of the these holes, in readiness for tapping.

Eight holes on the right-hand side, and ten on the left-hand side, are tapped in two stages at stations (7) and (8), which follow another idle position on the machine, and the castings then reach the turn-over station, mentioned earlier. A view of this station, taken from the right-hand side of the machine, so that the castings progress from left to right in the illustration, is given in Fig. 13. The transfer tracks of all four sections of the machine so far mentioned, are, of course, in line, but the track of the final section, to the right in Fig. 13, is displaced sideways for convenience. When the casting is transferred from the second of the tapping positions, at station (8), it is moved on to a platform *M*, Fig. 13, which is hinged in brackets at the further side of the track, and is here shown in the raised position.

This platform is raised and lowered by a hydraulic cylinder *N*, mounted in a vertical position at the side of the bed unit. The ram of this cylinder is connected to a lever, which is keyed to the hinge-pin of the platform, so that when the ram is moved upwards, the lever is turned and the platform is raised from the horizontal to the vertical position. When the platform is in the lowered position, it is level with the transfer track of the tapping stations, and it has curved fences at each side whereby the casting is centralized as it is advanced. Another view of the turn-over station, from the other side of the machine, is given in Fig. 14, and the casting is here seen in the position which it occupies after the platform has been raised. In this position, the casting rests with the milled faces of the twin hydraulic brake-band cylinders on the transfer track of the final section of the machine. When the transfer bar of this section is operated, by means of the horizontal hydraulic cylinder in the foreground, the casting is moved, on its side, to station (9) of the machine (the casting *P* is at this station).

The casting is located at the two tapping stations —numbers 9 and 10—by dowels in the vertical face of the bush plate at the right-hand side of the machine, as V-shaped clamping bars are advanced from the left. Each clamping bar is moved positively in both directions, horizontally, by means of a cam, as at *R*, on a vertical shaft.

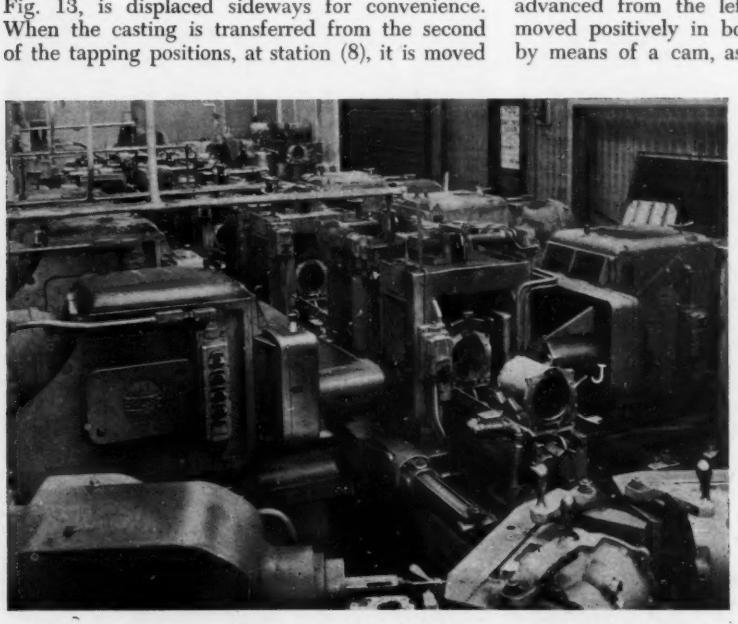


Fig. 12. Operations on the Side Faces, Including Machining of the Hydraulic Cylinder Bores, are Performed on this Baush 10-station Transfer Machine, which is Installed Close to the Machine in Fig. 10

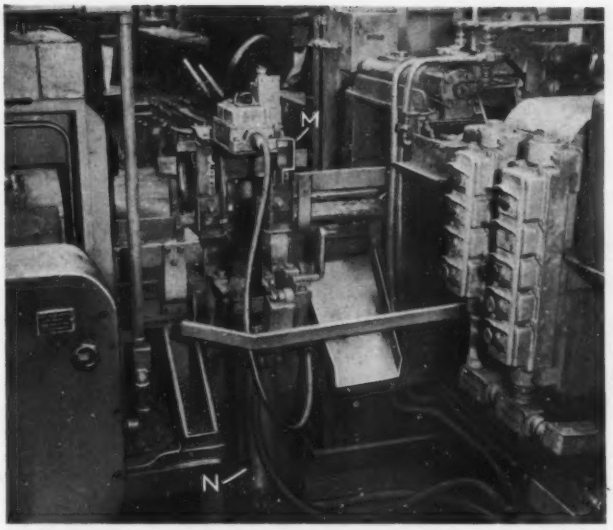


Fig. 13. Between Stations 8 and 9 on the Baush Transfer Machine, the Casting is Turned Through 90 deg. in a Vertical Plane, by Means of a Hydraulic Cylinder *N* on the Right-hand Side of the Machine

which is turned through rack and pinion by means of the hydraulic cylinder on the bridge member. A strap, connected to the clamping bar by plungers at each end, retracts the bar to release the casting when the cam *R* is turned in the direction for unclamping. After tapping has been performed at station (9), the casting is pushed off the two locating dowels by hydraulic ejectors in the right-hand bush plate, and is then ready for transfer to station (10), where it is clamped in a similar manner for the final tapping operations.

Tapping is performed only on the holes in the bottom cover face at stations (9) and (10), the left-hand positions being idle, and the taps are advanced under lead-screw control, the heads being held in fixed positions. The head at station (9) has 14 spindles, of which 12 are fitted with taps of $\frac{5}{16}$ in. by 18 N.C.2, and two with taper pipe taps of $\frac{1}{8}$ in. by 27 N.T.P., for the drain plug holes. The nine spindles of the head at station (10) carry $\frac{5}{16}$ in. by 18 N.C.2 taps, and all the taps employed on the machine are lubricated with a paraffin mist.

After being unloaded from the machine, the castings are passed to an Edlund drill press, fitted with a $\frac{3}{4}$-in. diameter core drill for the removal of casting flash from one of the holes in the rear face of the workpiece.

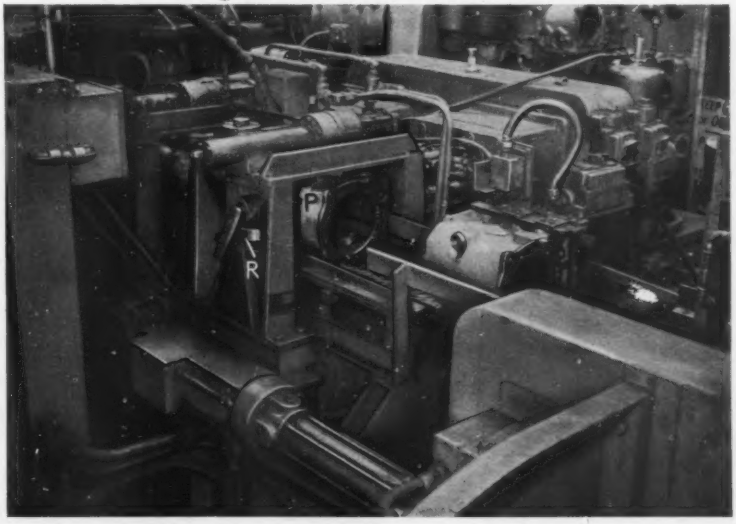


Fig. 14. In this View, from the Left-hand Side of the Machine, Further Details of the Turn-over Mechanism and of the Transfer and Clamping Arrangements can be Seen

BUHR FOUR-HEAD DRILLING AND BORING MACHINE

The next operations on the castings are carried out on the Buhr 4-way drilling and boring machine shown in Fig. 15, to which they are transferred on a chute. This machine has a central fixture, with projecting flat ways on which the casting is placed on its cover face, with the front face outwards, and pushed back into the clamping position. Locating

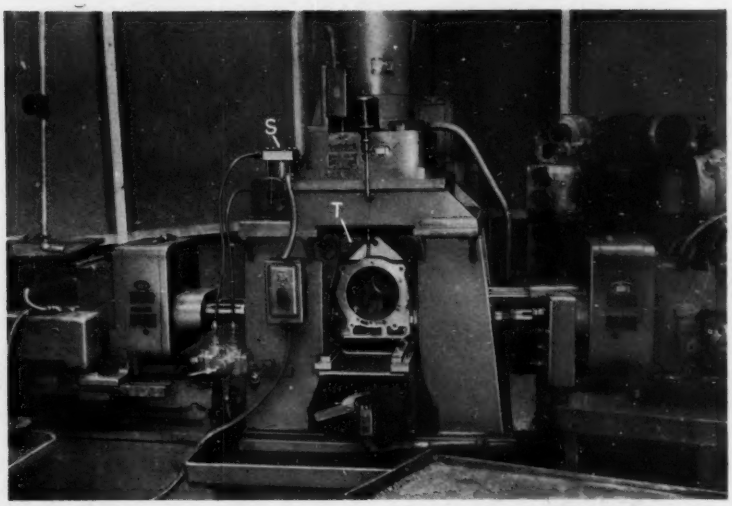


Fig. 15. This Buhr Machine is Employed for Grooving Operations on the Inner Ends of the Hydraulic Brake Band Cylinders, and for Facing the Inner Surface of the Boss Surrounding the Smaller Mainshaft Bore

dowels are then raised hydraulically to engage the holes *K*, Fig. 1, in the cover face, and the casting is clamped by means of the vertical hydraulic cylinder *S*, Fig. 15. The ram of this cylinder is connected to the outer end of a centrally-pivoted lever, and the inner end of this lever, seen at *T*, is fitted with a pressure-equalising pad in a position directly above the casting. There are horizontally-moving spindle heads on three sides, and a vertically-moving head above the fixture, and the machine operates on an automatic cycle.

Of the four heads, that at the right-hand side operates on the side of the casting with only one hydraulic cylinder, and is equipped with three spindles. Two of these spindles carry drills of 0·086 in. diameter and produce holes for name-plate rivets on the side of the casting. The other spindle is fitted with a Gairing facing and grooving tool, to which reference will be made later. This tool carries a single bit, which is employed to plunge-form the recess at the inner end of the hydraulic cylinder bore, to an angle of 15 deg. and a width of $\frac{1}{16}$ in. The left-hand head of the machine has two spindles, equipped with similar tools for machining the corresponding grooves which are required in the other two hydraulic cylinder bores.

Another Gairing tool, in the single spindle of the rear head, is employed to machine the area surrounding the mainshaft bore on the inside of the rear end of the casting. The vertical head has two spindles, equipped with taps of $\frac{3}{8}$ in. by 16 N.C.2, for threading holes at each end of the curved top surface of the casting, for eye-bolts whereby the assembled unit is lifted. For the grooving and facing operations, the spindles carrying the Gairing tools are driven at 110 r.p.m., and the tools are fed outwards at the rate of 0·001 in. per rev. The arrangement of a Gairing facing and grooving tool is shown in the drawing, Fig. 16, from which its action will be clear. This tool incorporates a main spindle *A*, with provision for driving at one end. Surrounding this spindle and keyed to rotate with it, there is a sleeve *B*, with six longitudinal rubbing strips set in peripheral slots. These strips support and guide the spindle in the bush *C*, which is held in the

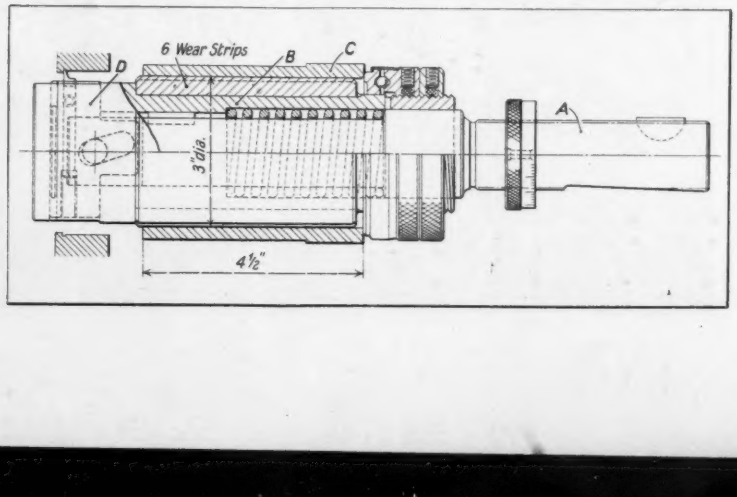


Fig. 16. Grooving and Facing Operations are Performed on the Buhr Machine with Gairing Tools of the Type Shown in this Drawing. The Tool-holder *D* is Advanced and Retracted by a Cam Slot

bush plate of the associated machine station.

A counterbore in the sleeve *B* accommodates a coil spring, which tends to push the sleeve towards the tool-holder at the left in the figure. At the right-hand end, the sleeve is threaded to receive two adjusting collars, which can be locked in place by means of socket grub-screws. One collar is integral with one race of a ball thrust bearing, and the other race is held in position by a formed ring. At the left-hand end, the shaft *A* is slotted to receive a tool-holder *D*, which carries a carbide tool-bit of the required form, provision being made for adjustment and clamping by means of socket grub-screws. The tool-holder *D* is of an approximate T-shape, and in the leg of the *T*, which projects into the slot in the shaft *A*, there is a cam slot. A pin passes through holes drilled in the end of the shaft *A*, and through the cam slot. While the tool is moving forward towards the work, the holder *D* is held in the retracted position by the action of the coil spring.

When one race of the ball thrust bearing comes into contact with the end of the bush *C*, further movement of the sleeve *B* and the tool-holder, in an axial direction, is prevented. As the shaft *A* continues to advance, the pin is carried along in the cam slot of the tool-holder, forcing the latter to move in a radial direction to the required depth for cutting the groove. When the direction of the spindle head movement is reversed, the spring holds the sleeve *B* in position while the shaft *A* moves back, and the tool is withdrawn radially. As soon as the pin reaches the other end of the cam slot, so that the tool is fully retracted, the sleeve *B* starts to move axially and the tool is carried back with the spindle head.

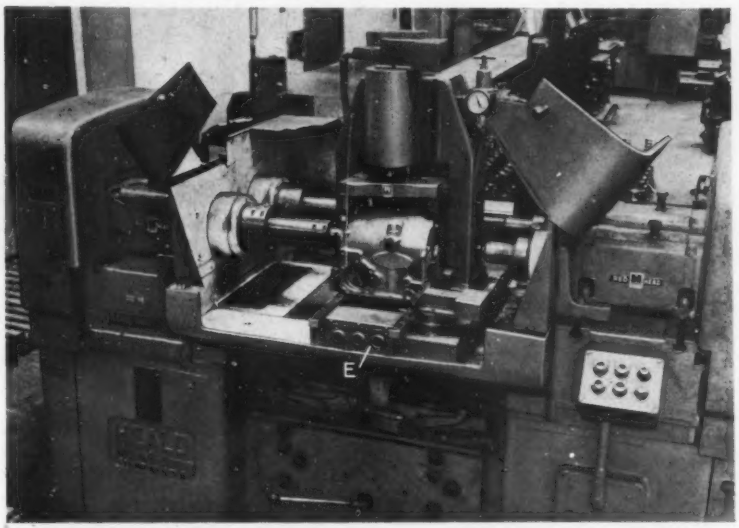


Fig. 17. The Front and Rear Mainshaft Bores are Finished, in Line, by Tools in the Left-hand Spindles on this Heald No. 46-B Automatic Fine-boring Machine, which Operates on Two Castings at a Time

OPERATIONS ON HEALD FINE-BORING MACHINES

Two Heald (Alfred Herbert, Ltd.), No. 46-B fine-boring machines are next employed for finishing the front and rear mainshaft bores and the hydraulic cylinder bores, to the dimensions given in Fig. 1. Both machines are equipped to operate on two castings simultaneously, and a view of the first machine, for the mainshaft bores, is given in Fig. 17. The castings are loaded on their bottom faces on flat ways which extend through the fixture, the rear station being loaded first. Locating dowels, which enter the holes *K*, Fig. 1, are raised and lowered hydraulically under the control of push-buttons, those for raising the dowels being mounted on the panel *E* at the front of the fixture. After loading the two castings and locating them successively by raising the dowels, the third button on this panel is pressed to apply the clamps. Clamping is effected by two direct-acting vertical hydraulic cylinders, held on a bridge structure above the castings. Each cylinder ram is fitted with a triangular pad which applies pressure at three positions on top of the casting.

The table, on which the fixture is mounted, is moved hydraulically on guideways towards the two spindles at each side, in succession, during

the automatic cycle of the machine, provision being made for rapid and feed traverses, and then it is returned to the central position for unloading. Each of the spindles at the left is equipped with five tools, three of which are carried at the nose end. These three tools are employed to finish-machine the smaller bore to 2·4408/2·4416 in., chamfer the inner end of this bore, and skim the inner face surrounding the bore. The two remaining tools are held in an enlarged diameter portion near the driven end of the boring bar, and serve to finish the larger bore accurately in line with the smaller, to limits of 6·3755/6·3775 in., and to chamfer the outer end. Each of the left-hand spindles has a single tool, for chamfering the outer end of the smaller of the two bores. It is specified that the two bores must be concentric within 0·0015 in. total indicator reading. Spindle speeds giving cutting rates of the order of 400 ft. per min. and feeds of 0·010 in. per rev. are employed.

After the table has been returned to its central position, pressure on a button, on the panel at the right of the loading position, serves to release the clamps and, at the same time, lower the locating dowels so that the castings can be pulled out on their supporting ways and loaded into the fixture of the second Heald machine, which faces that shown in Fig. 17. A close-up view of this second machine is given in Fig. 18, and the table is fitted with a somewhat longer fixture which accommodates two castings, in positions at 90 deg. to those occupied at the previous set-up. Apart from the different orientation, the castings are loaded, located and clamped in the same manner as on the first machine, spring-loaded latches, as at *F*, being provided for approximate positioning, before the locating dowels are raised.

The machine is equipped with four spindles on the left- and two on the right-hand side, which are tooled for finishing the three bores in each casting to 3·249/3·251 in. and chamfering the ends. A spindle speed of 480 r.p.m. is employed, and the table is fed in each direction at the rate of 0·002 in. per rev. to obtain the required surface finish of 50 micro-inches maximum roughness in the bores, over a length of $1\frac{1}{8}$ in. Normally, a finish of 30 micro-inches is maintained without difficulty. After they have been unloaded from the second Heald machine, the castings pass along another roller track to a No. 2 Kempsmith Maximiller horizontal milling machine equipped with three 6-in. diameter, $1\frac{5}{8}$-in. wide cutters, each with 14 inserted blades, which are run at 25 r.p.m. The casting is loaded on this machine with the arbor and its cutters projecting through the larger of the main-shaft bores, and, after it has been clamped, it is fed sideways, by hand, to a stop. In this manner, the cutters are brought into operation to machine slots in cored internal projections, near the top of the curved portion of the casting. These slots serve to retain and guide the brake bands in the assembled unit.

Next, on a New Britain (Vaughan Associates, Ltd.) single-spindle fine-boring machine, the two diameters of the hole *L*, Fig. 1, are finished to 0·4982/0·4992 and 0·8755/0·8775 in. by 0·292/

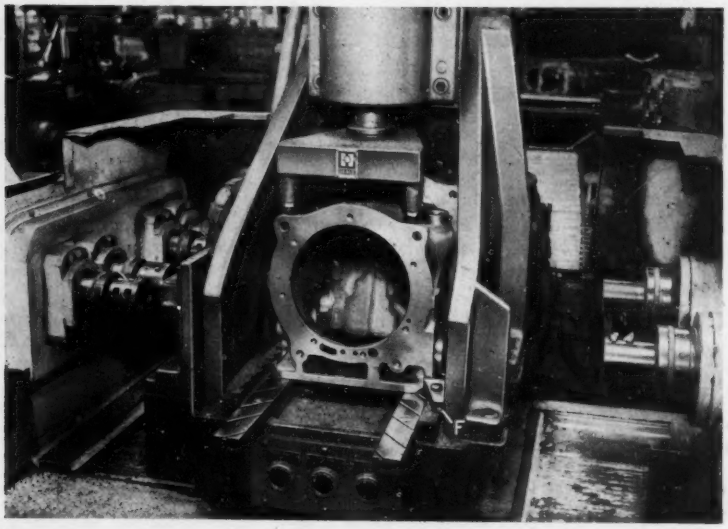


Fig. 18. Another Heald 46-B Machine is Employed for Finishing the Hydraulic Cylinder Bores on Two Castings at a Time. Initial Positioning of the Castings is Facilitated by Latches, One of which is Seen at *F*

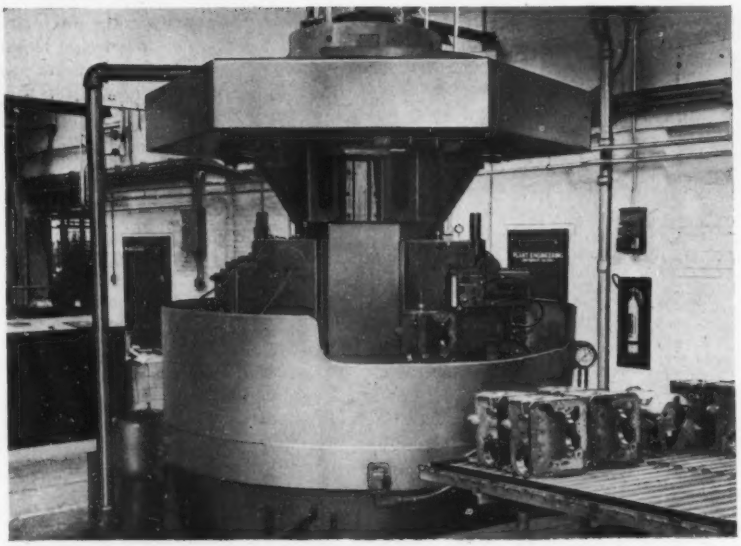


Fig. 19. As a Final Operation, the Front and Rear Faces of the Casting are Skimmed on this Special Bullard Contin-U-Matic Machine, to Ensure that they are Square with the Mainshaft Axis

0·302 in. deep. Subsequently, the castings are passed to a special Bullard (Buck & Hickman, Ltd.) type RD Contin-U-Matic 3-spindle fine-facing machine, a general view of which is given in Fig. 19. As may be seen, this machine is of the rotary type, with three spindles on which the castings are loaded with the mainshaft axes vertical. At one side of each spindle, there is a double toolslide equipped with two facing tools which are employed to finish the front and rear faces of the casting. These faces are required to be flat, and square with the axis of the mainshaft bores within 0·002 in. total indicator reading, and the surface roughness must not exceed 100 micro-inches. The distance between the faces is also held between 9·998 and 10·002 in. at this operation.

A close-up view of one of the spindles, at the loading station, is given in Fig. 20, and shows the casting in position with the front face downwards. The upper portion of the machine revolves continuously at a speed of one revolution in 3 min., and the drive to the spindles is so arranged that they run at about 100 r.p.m., except when they are passing the loading position, at which they are automatically stopped. As soon as the newly-loaded spindle has been carried clear of the loading position and has started to turn, the tool slides, which are actuated by a vertical hydraulic cylinder through rack and pinion, start to feed in. The tools continue to feed during approximately half a revolution of the machine, at the rate of about 4 in. per min. the maximum distance travelled, by the top tool, being approximately 6 in. As the spindle approaches the loading position again, the tool slides are retracted, the spindle stops, and the casting is unclamped ready for removal. The tools are tipped with Wimet S58 carbide, which will withstand the interrupted cutting for a longer period than a harder grade.

The spindles on which the castings are held are fitted with diaphragms which engage the mainshaft bores and are expanded by a hydraulic cylinder. A sectional drawing of the arrangement is given in Fig. 21, where the casting is indicated

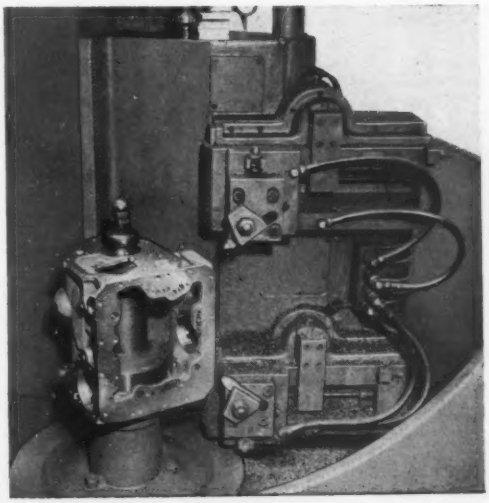


Fig. 20. Close-up View of the Loading Station of the Bullard Machine Showing the Casting in Position on the Vertical Spindle, and the Toolholders, which are Advanced Hydraulically

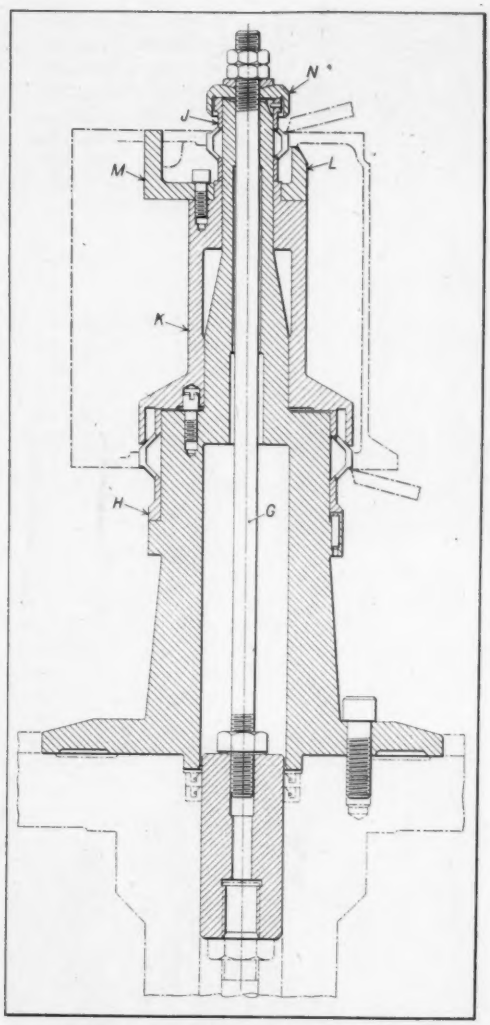


Fig. 21. A Sectional View Showing the Expanding Diaphragms Employed on the Bullard Machine for Gripping Two Mainshaft Bores of the Casting. The Diaphragm Slots are Filled with Rubber to Exclude Dirt

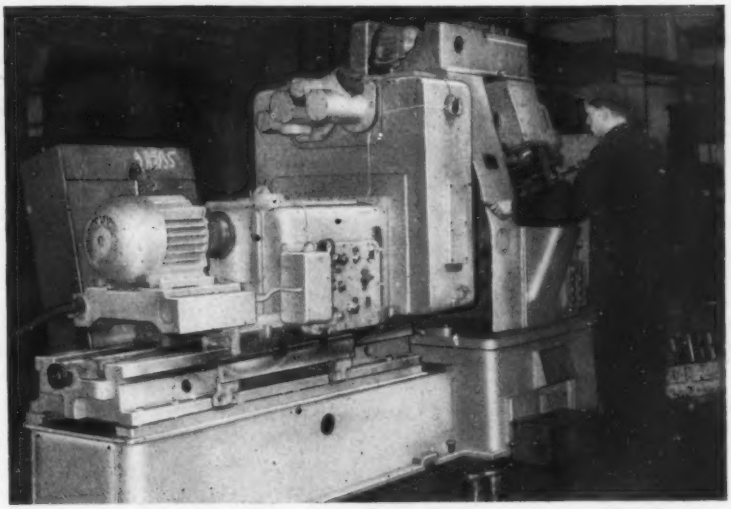
by chain-dotted outline, the draw-bar *G* being connected, at the lower end, to the ram of the hydraulic cylinder (not shown). The lower diaphragm, for the larger of the mainshaft bores, is shown at *H*, and the upper diaphragm for the smaller bore at *J*, and they are separated, on the spindle, by a pressure sleeve *K*. Each diaphragm takes the form of an annular ring of the section shown, made from hardened and tempered steel, with a number of equally-spaced radial slots, each $\frac{1}{16}$ in. wide in the enlarged central portion. There are 12 slots in the smaller, and 16 slots in the larger, ring, and their largest diameters are finish-ground to dimensions 0·001/0·0005 in. smaller than the lower limit on each bore, with the diaphragms in the free state.

When the casting is loaded on the spindle it rests with the inner face of the boss surrounding the smaller mainshaft bore in contact with a projection *L*, on the end of the spindle, which provides for endwise location. The casting is then turned, if necessary, until another projection *M* enters a cored hole in the rear end face, for driving purposes. Subsequent operation of the draw-bar, by means of the hydraulic cylinder, results in the pressure ring *N* being pulled downwards, and the two diaphragms are thus squeezed between the ring *N* and the supporting flange on the spindle. This pressure causes the diaphragms to expand into contact with the walls of the mainshaft bores, so that the axis of the bores is accurately aligned with that of the spindle. To prevent ingress of dirt into the slots, which might prevent the diaphragms from operating properly, the slots are filled with vulcanized rubber during manufacture.

In another article, to be published shortly, operations on mainshafts for the Borg-Warner automatic transmission will be described.

CUTTING COPPER WITH AN OXYGEN LANCE—Metallic Extractors, Ltd., Water Orton, Warwickshire, were recently required to reclaim a mass of raw copper weighing 85 tons which had solidified in a foundry as a result of a furnace breakdown. In order to recover this material it was necessary to break the mass into small pieces, and various methods were tried. Firstly, an attempt was made to break the copper by the impact of a 2-ton steel ball, and, subsequently, explosives were used, but neither expedient proved successful.

The copper was eventually cut by the thermic boring process, with the aid of an oxygen lance, which comprised a length of ⅜-in. diameter bore steel tubing packed with ⅛-in. diameter mild steel rods. Oxygen was passed through the bore of the tube, at a pressure of 100 to 150 lb. per sq. in., and then ignited. The reaction between the iron and the oxygen provided sufficient heat to melt the copper, and although a certain amount of heat was lost owing to the high thermal conductivity of the latter, it is stated that the method proved both efficient and economical.



Aspects of Russian Engineering Industry

Some Impressions Based on a First-hand Study of Soviet Plants

In the first of the articles in this series,* the growth of the machine-tool industry in the U.S.S.R. was discussed, and details were given of some of the latest types of Russian equipment. It was pointed out that, as the industry has grown, many new machine-tool works have been established in provincial cities, such as Odessa, Stalingrad and Minsk, but there is still a number of important plants in the neighbourhoods of Moscow and Leningrad, which at one time were the principal centres of Russian industry. In accordance with the decentralization policy for industry that is now in force in the U.S.S.R., severe limitations are imposed on the building of new factory accommodation in Moscow and Leningrad, and the plant buildings in these two areas are old and somewhat cramped. Nevertheless, they are efficiently equipped and staffed, and continue to make an important contribution to Russian industrial productivity. Two such plants—one in Moscow and the other in Leningrad—will be considered in this article and the one that follows.

ORDZONIKIDZE MACHINE-TOOL PLANT

The Ordzonikidze Machine-tool Plant is situated in the suburbs of Moscow, and is one of the most important machine-tool factories in this area. It was built during the first Five Year Plan, on land that previously had been used for market gardening. Construction of the factory buildings started in 1930 and they were completed in 1932. It may be of interest to note that a large number of the building workers, who came from outlying villages, studied machine-shop work during their spare time, and became some of the first operators in the plant. Many continued their studies at specialized institutes and technicums to become qualified engineers and technicians, and some 700 of the early workers in the plant obtained engineering degrees and many of them rose to executive positions at this and other factories.

Turret lathes were the first machines to be built by the Ordzonikidze works, and the production of turning machines of various types has always formed an important part of the plant's activities. Before the second world war, the production of 4-spindle bar automatics was initiated, these machines having capacity for work-material of 40 mm. (1·574 in.) diameter. During the war, the staff and production equipment were evacuated to the Urals, but returned to the Moscow factory on the cessation of hostilities. Since 1946, the Ordzonikidze plant has been engaged in the production of a wide range of metal-cutting

* MACHINERY—93/4–2/7/58.

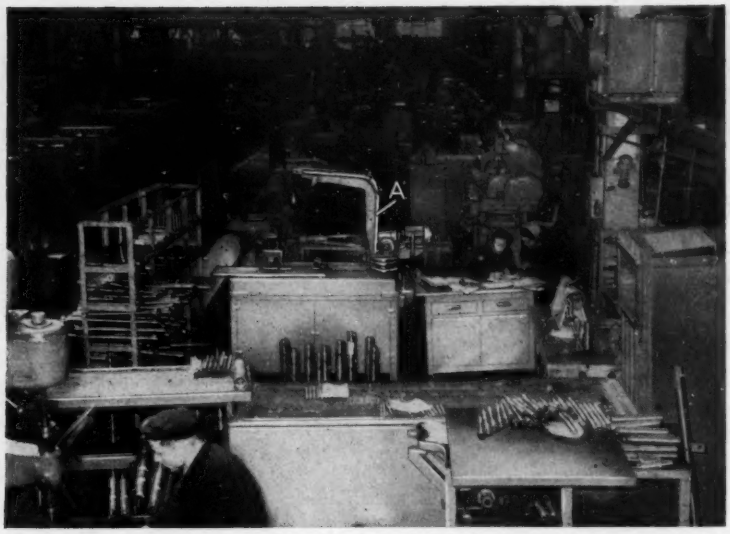


Fig. 1. General View of the Machining Department for Spindles, Shafts and Similar Components at the Ordzonikidze Machine-tool Plant, Moscow

machinery, of which about 70 per cent has been built to special order. In the latter category are included many transfer machines, as well as special-purpose units for drilling, boring and milling operations. The remaining 30 per cent of the output consists of standard machines, which are made in batches, and include 6-spindle automatics, and hydraulic copying lathes.

In all, about 300 different machines are built by the plant each year, and all are designed by the plant's own staff. There are two design offices, in which there is a total of 450 qualified engineers and other technologists. It may be of interest to note that many of the designers, technical workers and executives are women—including the deputy director—and that 56 per cent of all the graduates from higher technical institutions employed by the plant are women.

The total number of workers employed is approximately 4,000, and the plant is considered to be of medium size by Russian standards. As might be expected, a large proportion of the workers are highly skilled. About 50 per cent of the workshop employees are women, and to cater for married women workers with children, the plant maintains a nursery school and kindergarten with accommodation for 700 children. Such provisions are normal for works in the Soviet Union, and other facilities usually include a polyclinic and a library, both of which are provided at the Ordzonikidze plant. The library at this particular plant contains some 40,000 books and magazines, of which 7,000 are on technical subjects. It is associated with all other technical and public libraries in the Soviet Union, from which any book or periodical not in the plant library can readily be obtained. The library receives photo-lithographed copies of a large number of foreign technical journals—including MACHINERY—and it may be noted that these copies include all the advertisements, as well as the editorial matter. In addition, there is an abstracting and translation service for employees who can read only Russian. As in other Soviet plants, great importance is attached to the dissemination of technical information, and the library has a full-time qualified staff and excellent reading, storage, and records facilities.

The plant has a well-equipped machine maintenance and repair department which is housed in a separate building. Machines are overhauled in accordance with a carefully planned schedule, and about 10 per cent of the machines in the plant are treated each year. Of this proportion, it is usual to modernize half each year. Many of the older machine tools and equipment in the plant are being replaced, and 70 new machines were installed during last year. Most of these machines were of Russian origin, and during the present year it is planned to install 110 new machines. As new machines are installed, the old equipment that they replace is renovated and sent to the maintenance workshops of the collective farms in the agricultural areas of the Soviet Union. In addition to the facilities provided by the maintenance department, each shop has its own repair team for less extensive maintenance work and running repairs. The plant has ancillary departments for such services as heat-treatment, but does not operate a foundry, and castings are obtained from three foundries in the Moscow area.

MULTI-SPINDLE AUTOMATICS AND COPYING LATHES

Before the production facilities at the Ordzonikidze plant are described, it may be of interest to consider briefly the two standard machine tools that are built. The 6-spindle automatics are of conventional design, with all the refinements that might be expected on a modern machine of this type. Work-material up to 40 mm. (1·574 in.) can be accommodated, and the spindle speeds range from 156 to 2,120 r.p.m. The feed mechanisms for the radial tool slides are of the cam-less type, and incorporate adjustable ratio levers.

An Ordzonikidze copying lathe was shown in MACHINERY, 92/1477—20/6/58. Driven by a 20-h.p. motor, this lathe is arranged for longitudinal and transverse copying, and will accept workpieces of 400 mm. (15¾ in.) diameter, by 500 mm. (19⅛ in.) long. The maximum diameter than can be turned is 125 mm. (4·921 in.). There are 24 spindle speeds, ranging from 73 to 2,050 r.p.m., and the steplessly-variable feed rates vary from 20 to 700 mm. (0·787 to 27·5 in.) per min. longitudinally, and from 15 to 400 mm. (0·590 to 15·75 in.) per min. radially. Rapid traverse rates of 1·06 and 5·5 metres (3·5 and 18 ft.) per min. are provided in the longitudinal and radial directions respectively. The copying slide is hydraulically actuated, and is carried on a massive bridge member at the rear of the machine, above the work. An indexing template carrier enables successive cuts to be taken during the machine cycle, and the speeds and feeds can be changed automatically during the cutting sequence. Two hydraulically - operated, multi - tool in - feeding slides are mounted at the rear of the bed, below the bridge member, and the tailstock quill is hydraulically traversed and clamped. In addition to the single-spindle type, copying lathes of generally-similar design but with two spindles are being built.

At the time when this article was being prepared, no batches of copying lathes had reached the assembly stage, and the current batch of multi-spindle automatics was only in the early stages of assembly. In the main, therefore, the following description will be concerned with the layout of the Ordzonikidze works and its equipment, and with the building of special-purpose and transfer machines.

MAIN MACHINE-BUILDING WORKSHOPS

The main workshops of the plant are of reinforced concrete construction, with low-pitch roofs in which there are glazed panels for natural lighting. Most of the buildings have two or more bays, each of which is served by overhead cranes, and wherever possible each bay contains machines for the production of workpieces of similar nature. A general view of the bay for the production of spindles and shafts is given in Fig. 1. The machines are arranged so that the work flows from the end nearest to the camera towards the far end, and passes, in an orderly manner, through groups of lathes, drilling machines, hobbing and thread-milling machines, and grinding machines, for example. All the machines have individual motor drives, and are supplied from bus-ducting secured to the roof-supporting pillars, at either side.

Workpieces are transferred from machine to machine, and from shop to shop, by truck or crane, and individual handling aids are provided

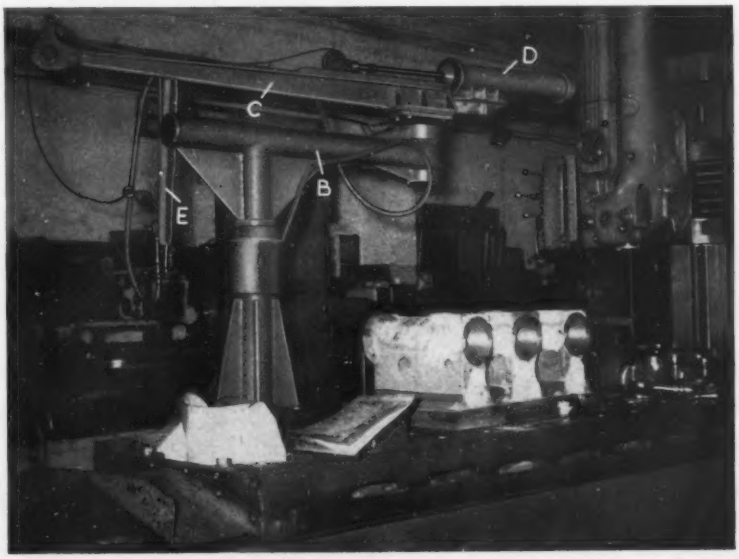


Fig. 2. This Floor-mounted Crane, Installed Adjacent to a Gray Plano-milling Machine, has a Swinging, Articulated Jib and Air-operated Lifting Gear

adjacent to machines, where necessary. One such aid may be seen at *A* in Fig. 1, and consists of a floor-mounted swinging jib, which is constructed from steel tube, with a strengthening web welded to the underside. A platform extends from the turntable at the lower end of the jib, and carries an electric motor, which drives a cable drum through a worm-reduction unit.

Another handling aid, shown in Fig. 2, serves a large Gray plano-milling machine, in an adjacent shop. In this instance, a well-braced tubular pillar is mounted on the floor, adjacent to the machine bed, and carries a swinging cross-member *B*, of tubular construction. At one end of the cross-member there is a bearing for the vertical spigot of a swinging arm *C*, which has a long-stroke air cylinder *D* at the right-hand end. At the end of the arm remote from the cylinder, there is a sheave, housed between side-plates. A length of wire-rope is anchored to the upper extension of these plates and passes round a pulley mounted on the end of the piston rod of the cylinder *D*, then back and over the sheave, the free end being secured to a weighted hook. The arrangement is such that the arm *C* can be swung through 180 deg. from the storage position shown, and the arm and cross-member *B* can be pivoted over the table of the plano-milling machine. A lever *E* extends downwards from the arm to facilitate movement, and carries a hand-operated valve for the control of the air supply to the cylinder *D*. When this valve is re-set, air is directed to the rod end of the cylinder, and the pulley on the end of the piston rod is moved to the right-hand end of the arm (as viewed in Fig. 2). As the pulley is moved, the wire-rope is drawn over the sheave at the end of the arm, and the hook is raised. It may be observed that the pulley runs in a channel-section guide to prevent it from turning in a plane normal to the axis of the piston rod, and, in consequence, twisting the loop of wire-rope. With this equipment, loads weighing up to 5 cwt. can be lifted from any part of the machine table, when the latter is traversed to the extreme position in front of the uprights.

The Gray plano-milling machine is shown during the course of setting-up for operations on tailstock bodies for copying lathes. It has two cutting heads on the cross-rail, and one head on each upright, and surfaces on the ends and tops of six bodies are machined simultaneously.

RUSSIAN OPTICAL JIG BORER

As might be supposed, the Ordzonikidze plant has ample provisions for precision boring operations, and there are horizontal boring machines in a wide range of sizes by Soviet and foreign makers, including several by Giddings & Lewis. Trepanning-type cutters are widely employed for boring operations, and are made in the works, the teeth being tipped with tungsten carbide, supplied by another Russian plant. In the same shop as the boring machines, there is a large Soviet-built vertical honing machine, which has capacity for finishing holes up to 500 mm. (19·685 in.) diameter by 2 metres (6·56 ft.) long.

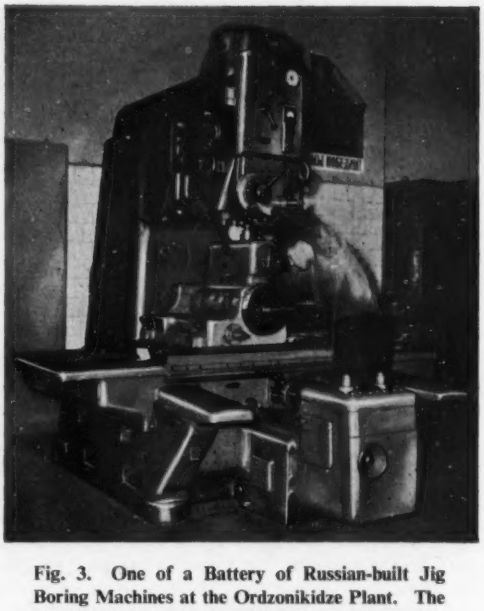


Fig. 3. One of a Battery of Russian-built Jig Boring Machines at the Ordzonikidze Plant. The Machine has an Optical Measuring System, and Repeat Settings can be made to an Accuracy of 1 micron (0.00004 in.)

In addition to the horizontal boring machines, there is a battery of jig-boring machines. Two machines of this group were built by Société Genevoise—and others of the same make are installed in other sections of the plant—and there are four machines built by one of the Moscow machine-tool factories. One of these Russian jig borers, which were introduced in 1956, is shown in Fig. 3, and it may be observed that it closely resembles the Lindner type No. 15. The table measures 1,000 by 600 mm. (40 by 24 in. approximately), and the machine has an optical measuring system for work positioning. It is stated that repeat settings can be made to an accuracy of 1 micron (0·00004 in.), and the spindle speeds and feeds are steplessly variable. To facilitate setting, and to

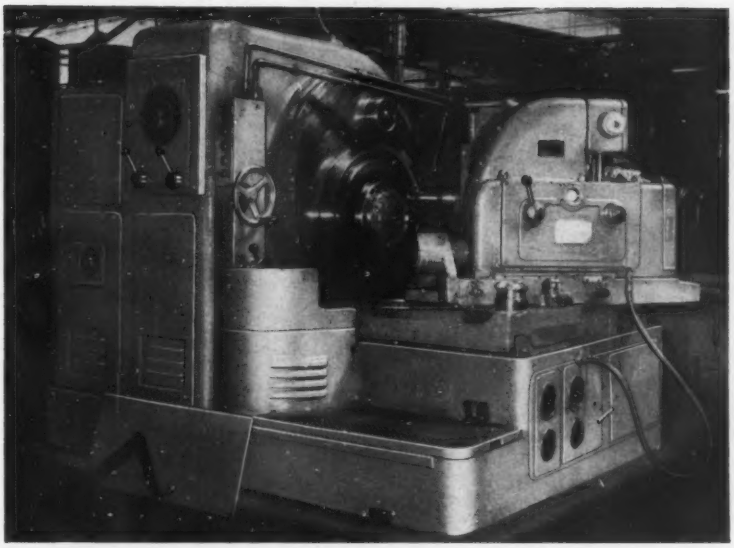


Fig. 4. Designed by ENIMS, and Built by the Moscow Machine-tool Plant, this Spiral Bevel Gear Generator has Capacity for Cutting Gears of 800 mm. (31·496 in.) Maximum Diameter

reduce the possibility of errors, the hole positions on drawings of all parts that require jig-boring, are located by x and y co-ordinates from a datum point. Each co-ordinate is given a letter reference, and the actual dimensions and tolerances are tabulated at one side of the drawing.

The plant has an extensive gear production section, and among the equipment installed is the large generating machine for spiral bevel gears shown in Fig. 4. Designed and developed by the machine-tool research centre (ENIMS), to which reference was made in connection with the gear generator and grinder in the first article in this series, this unit was built by the Moscow Machine-tool Plant, and has capacity for cutting gears up to 800 mm. (31·496 in.) diameter, with teeth of 20 module (maximum). The principle of operation is similar to that of the Gleason generators for spiral bevel gears, one tooth being cut at a time by a rotating and oscillating multi-tooth cutter. A heat-treatment department for gears is located in a separate shop adjacent to the gear-cutting section, and among the equipment installed is a large high-frequency unit for hardening gear teeth.

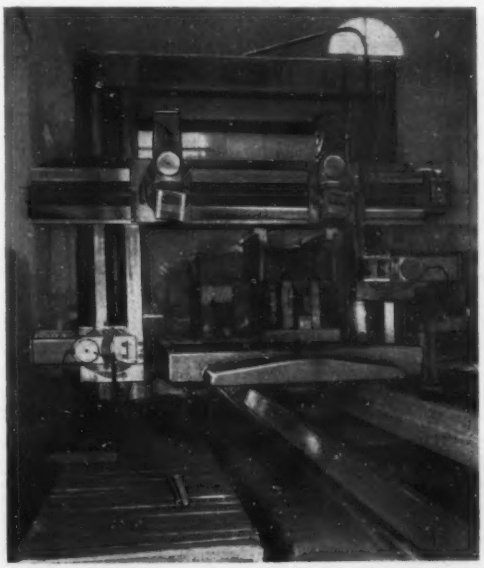


Fig. 5. One of the Latest Planers to be Installed at the Ordzonikidze Plant is this Large Russian-built Machine. The Table is Hydraulically Powered, and Workpieces Measuring Approximately 33 ft. long by 8 ft. square can be Machined

LARGE RUSSIAN PLANING MACHINE

For initial operations on castings, the plant has an extensive range of planing and plano-milling machines, and the use of a Gray plano-miller has already been noted. Many of the machines are of foreign origin—mainly from Britain and the U.S.A.—and are ten to 15 years old. One of the largest planing machines in the works is seen in Fig. 5, and is a modern Russian type, which has only recently been installed. This unit can be used for machining workpieces up to 10 metres (33 ft.)

Fig. 6. One End of the Assembly Bay for Large Jigs and Fixtures Used on Special-purpose and Transfer Machines

long and 2·5 metres (8·2 ft.) wide and high, and has a hydraulically-operated table. The four tool-heads are provided with automatically-actuated clapper boxes, whereby the cutting tools are swung clear of the work for the return stroke, through the action of a solenoid on each box. Planing is carried out to close limits, and there is no grinding of machine slideways, these surfaces usually being finished with a very broad flat tool.

There is a very large heat-treatment department, housed in a separate building, where hardening, tempering and allied operations are performed on components other than gears. All the work-spindles of the machines built at the Ordzonikidze plant are nitrided, and there is a pit-type furnace for this treatment which has a depth of 6 metres (about 20 ft.). Another furnace of a similar type was under construction at the time that this article was prepared. There are four large furnaces for general heat-treatment, all of which are fitted with push-button operated doors. These furnaces, and the others in the department, were oil-fired originally, but they have been converted for heating by natural gas. There are plentiful supplies of this heating medium in the Soviet Union, and the gas is now supplied to all the main industrial centres by a grid system. A large battery of salt-bath furnaces is installed for tempering operations, and these units are arranged for fully-automatic control.

Conditions in the heat-treatment department are remarkably good. The floor-area is covered by an overhead travelling heavy-duty gantry crane, and auxiliary handling equipment is provided where necessary. Particular attention is paid to ventilation and to cleanliness of the building and equipment. In accordance with general practice in the U.S.S.R., moreover, the operators in the heat-treatment department receive special rates of pay and additional leave. It may be of interest to note that the minimum wage is 1,060 roubles per month.*

MACHINE ASSEMBLY FACILITIES

As has already been pointed out, building restrictions in the Moscow area have prevented expansion of the plant during recent years, and their effect is particularly noticeable in the assembly sections, where conditions are somewhat cramped. A general view of one end of the assembly bay for large jigs and fixtures is given in Fig. 6. Here, the tooling equipment for special-purpose and transfer machines is built. The procedures adopted are quite conventional, hand fitting and the building of sub-assemblies being carried out at benches that are located along the walls at each side, while the main units are assembled on surface plates that are mounted on brick supports in the centre of the floor area. An overhead gantry crane covers the whole of the bay. From a rather limited visual examination, the general standard of fitting appeared to be high, and there was much careful scraping of slideways and mating surfaces. As far as could be seen, little use was made of portable power tools.

Special-purpose and transfer machines built at the Ordzonikidze plant incorporate large numbers of unit-heads for drilling, milling, boring and similar operations, and a range of six standard units has been developed. The unit heads are assembled in a special section of the plant, and Fig. 7 is a view of one end of this department. Heads are built in batches and are tested in an adjoining

* The standard rate of exchange is 11 roubles to £1, but it is considered by many authorities that, for the comparison of wages and prices in the U.S.S.R. and Great Britain, a rate af approximately 35 roubles to £1 is more realistic.

bay, all adjustments and setting that are necessary being carried out in the assembly department, in order to save time in the main machine building sections. The heads seen partly assembled in Fig. 7 are the smallest in the standard range, and have a maximum travel of 100 mm. (3·937 in.), the maximum size of hole that can be drilled being 5 mm. (0·196 in.).

The unit heads are of orthodox design, and each head is moved on the square guideways of a base casting by hydraulic power. A cylinder is mounted between the guideways of the base and the end of the piston rod is secured to the head unit. Length of traverse is controlled, and the feed, rapid approach and rapid return motions are engaged, by dogs and trip-actuated valves, the traverse rates being adjusted by means of manually-operated flow-control valves. The valves and hydraulic equipment are built in the U.S.S.R., and are generally similar in design to those supplied by Vickers-Detroit. The lengths of traverse of the other five heads in the range vary from 250 mm. (9·842 in.) for the second smallest unit, to 1,000 mm. (39.370 in.) for the largest head. The maximum cutting thrust that can be applied ranges from 850 kg. (385 lb.) to 10,000 kg. (4,536 lb.), and the output of the driving motors from 6 to 37·5 h.p.

A typical Ordzonikidze special-purpose machine that incorporates unit heads from the standard range is shown in the heading illustration. This machine has been designed for performing boring and other operations on the gudgeon-pin holes of pistons for tractor engines, and is to be installed in one of the new Soviet plants. Two frames and a cross-head, of welded construction, are mounted in the middle of the machine base, to form a bridge structure, which supports a work-carrying drum. The drum can be indexed, in a vertical plane at 90 deg. to the longitudinal axis of the machine, and has five flat faces, whereon are fitted fixtures to hold the work. Unit heads are mounted on sub-bases at either side of the central bridge structure, and each head is fitted with a large multi-spindle adapter.

A close-up view of the bridge structure of the machine is given in Fig. 8, and one of the drum fixtures may be seen in the loading position. Each fixture holds two pistons, which are clamped by swivelling pads at either end of a cross-bar. These pads compensate for slight discrepancies in the overall lengths of the pistons, and the cross-bar is pulled inwards, for clamping, by a rod which extends outwards radially from the drum. The cross-bar is supported on a compression spring, surrounding the rod, and the end of the latter member is threaded and fitted with nuts, to provide for adjustment of the cross-bar position. Clamping pressure is released, and the bar swung through 90 deg. to clear the workpieces, by movement of a lever at the left-hand side of the loading position. This lever actuates a sliding plunger which engages the clamping mechanism of the work-station at the loading position.

Pistons are loaded with their crowns outwards, and each is passed between four cone-end pegs, that project from the fixture and serve to guide the piston, so that a register-bore at the lower end of the skirt engages a shallow spigot on the fixture base. The pistons are located angularly by two plungers that slide in a bearing block on the right-hand side frame of the bridge structure, at the

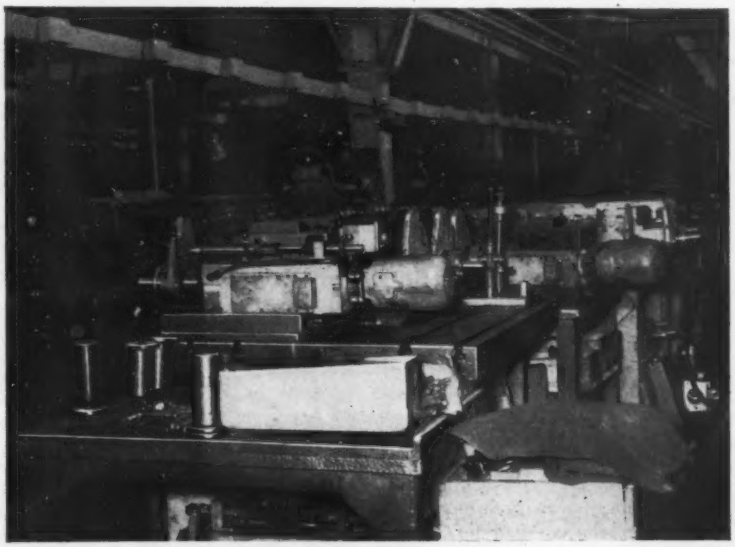


Fig. 7. This Section of the Ordzonikidze Plant is Devoted to the Assembly and Adjustment of Standard Unit Heads, which are Built in a Range of Six Sizes

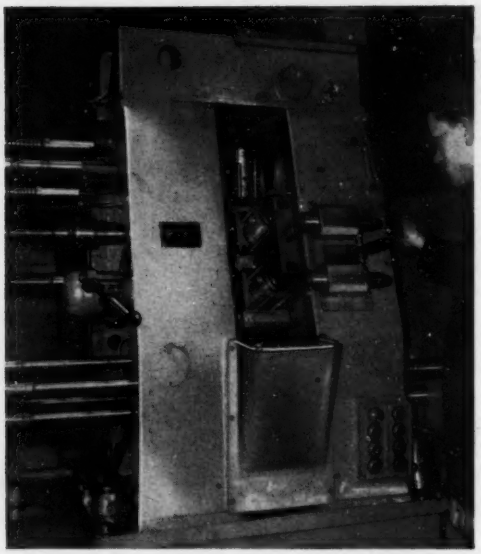


Fig. 8. Close-up View of the Special-purpose Machine for Pistons, Seen in the Heading Illustration. Two Pistons are Loaded on Each of Five Stations of the Indexing Drum

loading position. Each plunger has a projection, of rounded-off diamond section, at its left-hand end, and both plungers can be moved to the left, against spring-pressure, by means of the lever that the operator is holding in Fig. 8. In their extreme left-hand setting, the projections on the plungers engage the cored gudgeon-pin holes in the piston castings, to position them correctly, with the holes parallel to the cutting tools. The right-hand end of each plunger is of truncated conical form, and a limit switch with a roller-lever actuator is mounted above the upper plunger. When the plungers are in engagement with the workpieces on the machine drum, the conical end of the upper plunger is clear of the switch actuator, and the switch contacts are opened. In consequence, the control circuit of the machine is broken and the semi-automatic cycle cannot be engaged. As the plungers are withdrawn from the work, the cone end of the upper plunger trips the actuator to close the switch, and the cycle can be initiated by depressing a push-button on the control panel to the lower right of the loading position.

The machine cycle occupies 1½ min., and the operations include core-drilling, boring, reaming, countersinking, and machining a circlip groove at each end of the gudgeon-pin hole.

Fig. 9 shows a group of large copy-milling machines which have been built to special order by the Ordzonikidze plant. The cutter spindle of each machine is driven by a 20-h.p. motor, and copy-milling is performed under the control of a hydraulic system. A motor-driven pump and reservoir unit is mounted at the right-hand side of the machine base (as viewed from the front), and the cutter head, table and saddle are coupled to the piston rods of hydraulic cylinders. The follower unit is secured to the right-hand side of the cutter head, and the tracing stylus engages a master mounted on an adjustable support at the end of the machine table. Copying-masters are secured to a T-slotted platform which has screw-adjustment vertically, and in two directions at 90 deg. in the horizontal plane, and the platform can also be rotated. Micrometer drums and a protractor scale are provided to facilitate setting. The follower stylus has screw adjustment vertically. Three-dimensional copy-milling can be performed, and the largest workpiece that can be accommodated measures approximately 20 in. in each direction.

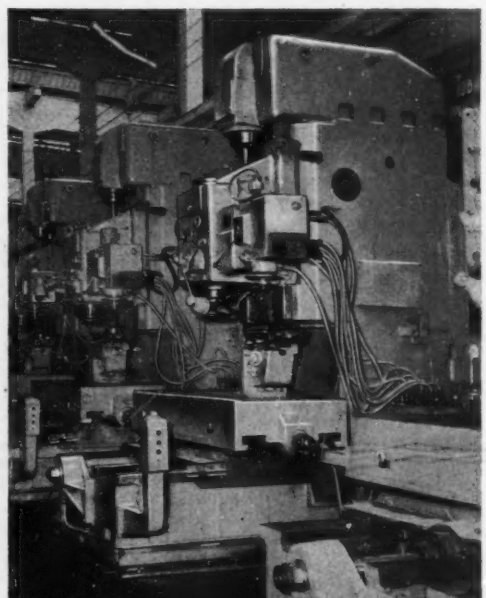


Fig. 9. A Group of Large Hydraulically-operated Copy-milling Machines which have been Built in the Ordzonikidze Plant to Special Order. Workpieces Measuring Approximately 20 in. in Each Direction can be Machined

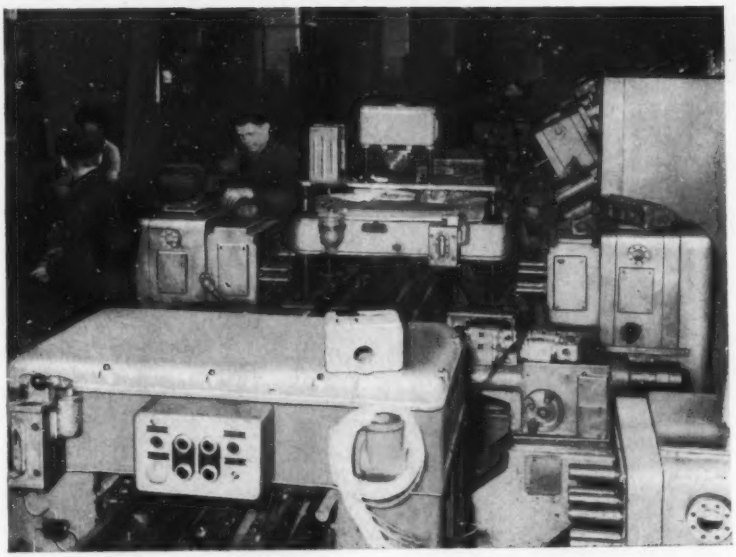


Fig. 10. A View from One End of an In-line Transfer Machine for Operations on Cylinder Heads. An Average Output of Two Transfer Machines Each Month is Maintained

AUTOMATIC TRANSFER MACHINES

As has already been mentioned, the building of automatic transfer machines is an important function of the Ordzonikidze plant, and an average output of two transfer machines per month is maintained. Two transfer machines were in the course of construction at the time when this article was prepared, and one, which was at an early assembly stage, is designed for machining electric motor bodies. The machine is of the in-line type, with six working stations, and at each station there are horizontal and vertical unit-heads, the total number of heads, of different sizes, being 38. Each motor body is mounted on a pallet-type fixture, and is located by the previously-drilled fixing holes in the feet. Operations are carried out on the two ends, also on the connection box, and this transfer machine will eventually replace 12 different standard machine tools.

The other transfer machine is shown in Fig. 10, and provides for machining motor-car cylinder heads. As may be observed, it is of orthodox construction, with unit heads, fitted with multi-spindle adapters, disposed alongside horizontal transfer ways. The heads are mounted on horizontal or angularly-disposed base units, or on vertical columns, and, in this instance, pallets are not used, the cylinder-head castings being moved, in direct contact with transfer ways, by hydraulically-actuated shuttle bars. Workpieces travel from the end of the machine nearest to the camera in Fig. 10, and, when they have passed through the first group of machining stations, are swung through 90 deg., and proceed through the remaining stages on their sides.

At the end of the assembly bays, there is a re-touching and packing section, and the gantry crane that covers this department can pass directly over a railway loading dock outside the building. About 30 per cent of the output of the Ordzonikidze plant is exported—principally to countries in the Communist bloc, but also to eastern countries and the Middle East—and in the despatch bay there were several special-purpose machines for India. These machines were designed for drilling the ends of railway rails, to receive the fixing bolts for the fish-plates. Each machine had a horizontal drilling head, with a multi-spindle adapter, and the rail was hydraulically clamped. As the machines were required to work under tropical conditions, special materials, such as stainless steel, were used for the exposed metal parts.

In the next article in this series, to be published shortly in MACHINERY, details will be given of another Soviet machine-tool plant, and one of the Russian cutting tool factories will be described.

"THIN-WALL" POLYTHENE CARBOYS.—Polythene has been employed in the manufacture of heavy-walled carboys for some time, but Fibrenyle, Ltd., 157 Dukes Road, Western Avenue, London, W.3, announce that with improved techniques it is now possible to use this material for the production of light-weight thin-wall carboys. These containers are being made at present in three sizes, of 5-, 10-, and 15-gal. capacity, and when required for heavy duties can be supplied complete with protective wire cages, or, alternatively, with armoured metal drums.

East German Inspection Equipment For Bearing Balls, Races, and Camshafts

VEB Feinmesszeugfabrik Suhl, East Germany, who specialize in the production of gauging and fine measuring equipment, have developed a range of fully-automatic and semi-automatic inspection units for use in the ball and roller bearing industry, which have features of interest.

For grading steel balls according to diameter, three fully-automatic machines are available, covering sizes from 1·5 to 6 mm. (0·060 to 0·236 in.), 4 to 10 mm. (0·157 to 0·39 in.), and 8 to 30 mm. (0·315 to 1·181 in.). Gauging is entirely mechanical on all these machines, and the type No. 4130 for balls from 4 to 10 mm. diameter is illustrated in Fig. 1. It has a capacity for 15,000 to 18,000 balls per hour, and the method of grading, which is the subject of patents, is shown in a diagrammatic form in the line drawing, Fig. 2.

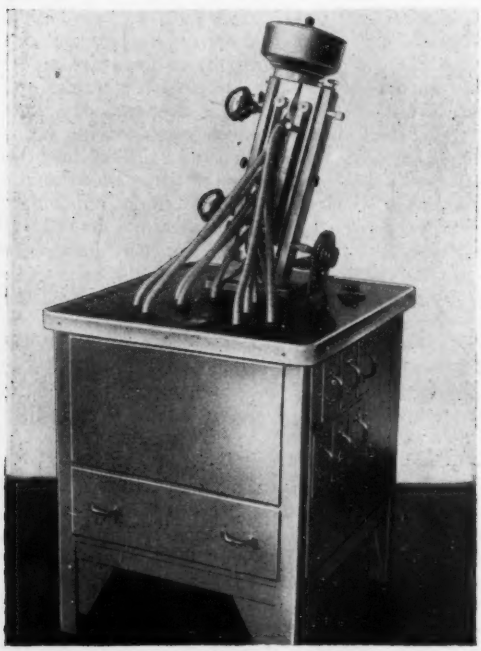


Fig. 1. Automatic High-speed Grading Machine for Balls from 4 to 10 mm. Diameter, Developed by VEB Feinmesszeugfabrik Suhl

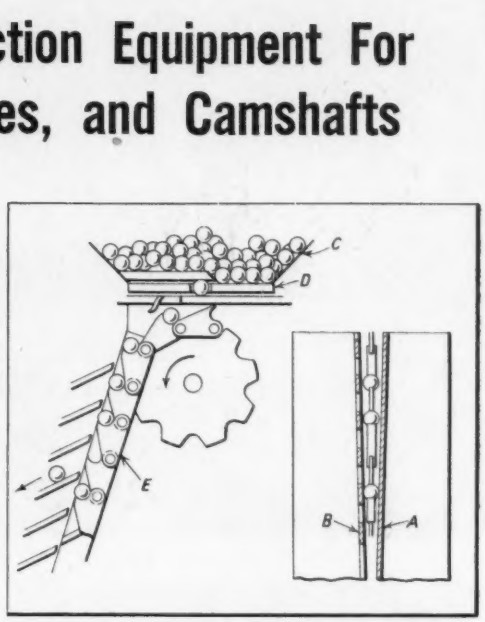


Fig. 2. Diagram Showing the Principle of Operation of the Machine Seen in Fig. 1

The measuring elements consist of a plain straightedge *A*, and a second straightedge *B*, composed of separate inserts corresponding in number to the gradings required. These straightedges are hard-metal faced, and are inclined to each other to form a tapered gap which can be accurately set with the aid of micrometers in conjunction with dial gauges reading to 0·00004 in. The balls to be graded are loaded into a hopper *C*, from which they are transferred, one at a time, by a feed slide *D*, into pockets formed in the links of a chain *E*. The latter is driven at constant speed, and when a ball reaches the point where it will not move any further in the taper gap, it is ejected, by contact of the sloping face of the chain link, into the appropriate grading channel.

With this machine, it is stated, balls can be graded in steps as small as 0·001 mm. (0·00004 in.), and there are 10 grading channels and plus and minus reject channels. It is claimed that, because the balls move in the taper gap at a controlled and relatively slow speed, a high grading accuracy is ensured, and wear on the straightedges is minimized.

In the machine for grading the smaller sizes of

balls, from 1·5 to 6 mm. diameter, it is not possible to use a conveyor chain because of space limitations, and the principle employed is shown diagrammatically in Fig. 3. The ball rolls down a straightedge *A*, which is inclined slightly in two planes, and the grading gaps are formed by upper anvils *B*, carried in a block which can be accurately adjusted to the required position by micrometers *C*, in conjunction with dial indicators. In the lateral direction, the ball is guided by the vertical face *D* of a gate *E*, and at each cycle, the latter is swung outwards, about pivot points *F*, by means of a cam-actuated pusher *G*. The ball arrested at the grading position is thus ejected into the relevant container by contact of the rear face *H* of the gate, which is serrated to form guide pockets. Transverse movement of the gate also actuates a detent *J*, which allows the balls to roll in turn down the hopper guide channel *K*, up to an end plate *L* on the gate. Upon the return stroke of the latter, the ball is admitted to the grading track through an aperture in the end plate. On this machine, balls can be sorted into six grades, in minimum steps of 0·001 mm. (0·00004 in.) at the rate of 4,300 to 5,300 per hour.

With larger sizes of balls, up to 30 mm. diameter, the momentum resulting from rolling freely would impair the grading accuracy, and might also cause undue wear on the gauging surfaces. For this reason, a somewhat different arrangement is employed, as shown in the diagram, Fig. 4.

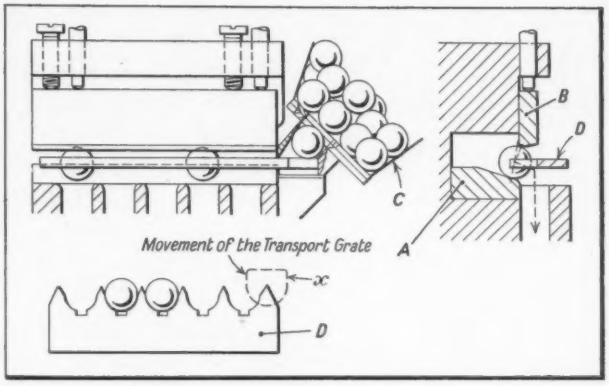


Fig. 4. Arrangement of the Suhl Grading Machine for Balls from 8 to 30 mm. Diameter

Here, the balls are moved progressively between a straightedge *A*, arranged horizontally, and an upper straightedge *B*, which is adjusted to give the required taper gap. The traversing motion, synchronized with the release device of the hopper *C*, is imparted by a plate member *D*, which is provided with a series of pockets and is caused to move through the path indicated by the dotted line *X*. Thus, when a ball reaches a point corresponding to its grade diameter it will move laterally, with the plate *D*, and fall into the appropriate container. Balls from 8 to 15 mm. diameter can be sorted into 10 grades in minimum steps of 0·001 mm., and plus and minus rejects, at rates up to 6,000 per hour. The larger balls can be sorted into five grades, and plus and minus rejects, at rates up to 3,600 per hour, depending upon the diameter.

Fig. 5 shows a machine incorporating plane adjustable straightedges which is intended for carrying out a preliminary sorting operation on balls from 6 to 16 mm. diameter (0·236 to 0·63 in.), before they are finally graded. With this machine, grading can be carried out in steps down to 0·005 mm. (0·0002 in.), and the balls can be sorted into 10 grades and plus and minus rejects. The two straightedges, together with the micrometers and dial gauges for adjusting the taper gap, are carried in a base member, which can be tilted to an angle of 10 to 20 deg., according to the size of ball that is being handled. From the feed hopper, the balls are re-

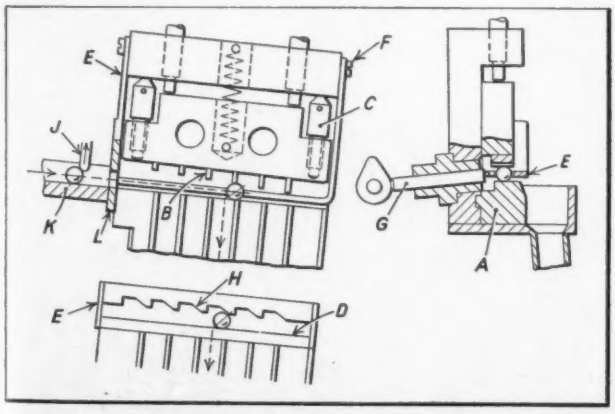


Fig. 3. Principle Employed in the Suhl Grading Machine for Balls from 1·5 to 6 mm. Diameter

leased, one at a time, into a V-guided channel, which is adjustable and serves to steady the ball before it rolls by gravity into the taper grading gap. Up to 3,600 balls can be graded per hour, depending upon the diameter.

SEMI-AUTOMATIC SORTING MACHINE FOR DIAMETER AND ROUNDNESS

For checking both the diameter and roundness of balls from 5 to 16 mm. (0·197 to 0·63 in.) required for anti-friction bearings of very high precision, a semi-automatic machine shown in Fig. 6 has been developed. On this machine, a push-button is depressed to release a ball from a hopper into a pocket in a rotating transfer plate, which then indexes to bring the ball to the inspection position beneath the anvil of a Suhl Optikator comparator. The operator observes the result of the test on the comparator scale, and then depresses the appropriate button of a row, which causes the transfer plate to index again, and the inspected ball is delivered into the appropriate grading container. Ten selector push-buttons are provided, of which six relate to diameter gradings, and one each to "plus" "minus," "out of round," and "repeat." Balls are directed to the "repeat" container when it is desired, for any reason, to check them again. To prevent damage to the balls, the indexing transfer plate, the delivery chutes, and the containers, are plastics lined.

A 3-point gauging principle is employed as shown in the diagram, Fig. 7. The ball *A*, to be tested, is held in contact with the stationary anvils of three micrometer heads *B*, which are arranged at 120 deg. to each other, and the stem *C* of the Optikator comparator moves down into contact with the top of the ball. Upward pressure, to hold the ball against the three anvils, is exerted by a small rubber roller *D*, which can rotate freely on its horizontal axis. The carrier in which the roller is mounted is rotated about a vertical axis, and the resulting rotary motion of the ball causes the latter to be gauged at continually changing points during the

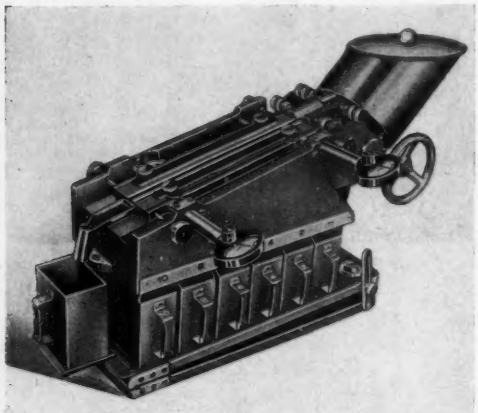


Fig. 5. Suhl Automatic Machine for the First-stage Grading of Balls from 6 to 16 mm. Diameter

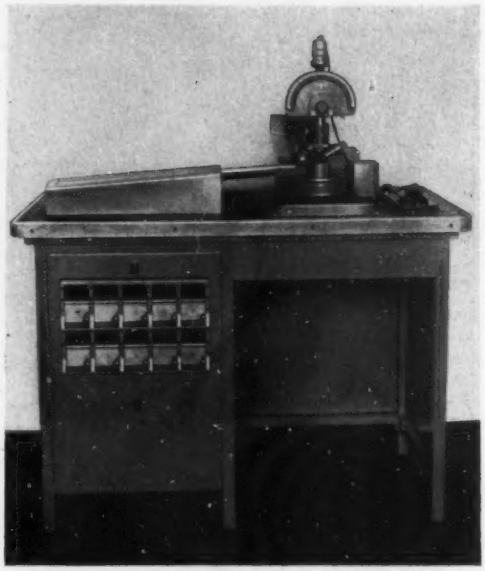


Fig. 6. Suhl Semi-automatic Machine for Checking the Diameter and Roundness of Balls from 5 to 16 mm. Diameter

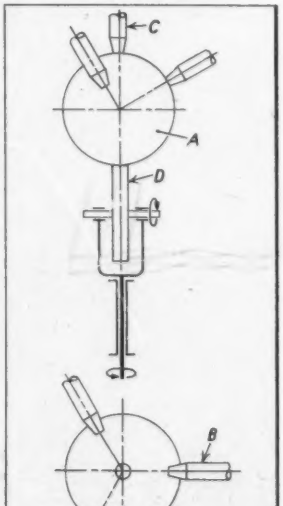


Fig. 7. Diagram of the Principle of the Diameter and Roundness Testing Machine

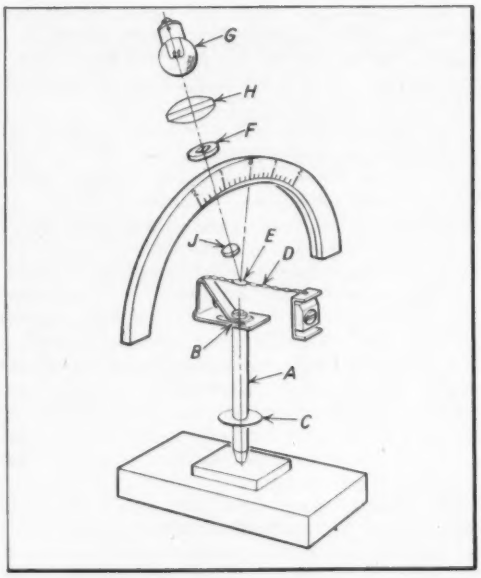


Fig. 8. Schematic Arrangement Showing the Construction of the Suhl Optikator Comparator

test. Any out of roundness can thus readily be observed on the comparator scale. The anvils of the micrometers and the comparator are normally tungsten-carbide faced, but they can be diamond faced, if required.

The Optikator comparator is of the torsion-strip type and can be supplied with a scale reading to 0·0001 mm. (0·000004 in.) or 0·0002 mm. (0·000008 in.), the corresponding measuring ranges being ±0·012 mm. (0·00048 in.) and ±0·025 mm. (0·00096 in.). A feature of the instrument is that the scale readings are obtained by means of a combined optical and mechanical system which provides magnifications of 5,000× or 10,000×, and the arrangement is shown diagrammatically in Fig. 8.

The stem *A* of the instrument is supported in upper and lower spring-steel membranes *B* and *C*, so that it moves without friction, and the upper membrane *B* forms, in effect, a bell crank, to which one end of the twisted torsion strip *D* is attached. At the opposite end, the strip is anchored to an adjusting device whereby the scale reading may be set to zero. Fastened to the torsion strip is a small mirror *E*, which tilts as the strip is twisted by axial movement of the stem *A*, and causes an image of a line graticule *F* to be reflected on to the scale. The light source is indicated at *G*, and the optical system incorporates a 3-component condenser *H*, and a 2-component objective *J*. A very high degree of sensitivity is claimed for this optical pointer system, which, in addition, provides readings free from parallax. Another feature of the instrument is that optical tolerance markers, adjustable, by means of two screws, over the entire measuring range, are incorporated. If the workpiece is outside the prescribed tolerance on the plus side the luminous pointer will appear green, and on the minus side, red. A sensitive lever arrangement, which is self-locking in the retracted position, is fitted for lowering the stem into contact with the workpiece.

CHECKING BORE TO FACE SQUARENESS OF BEARING RACES

The Optikator comparator is also employed in the instrument seen in Fig. 9, which has been designed for checking the squareness of the face with the bore of a bearing race. For testing purposes, the bearing ring is placed face downwards on the table of the instrument, as seen at *A*, and it is held by means of a rubber disc against

Fig. 9. Instrument Incorporating an Optikator Comparator for Checking the Bore-to-Face Squareness of Bearing Rings

an outer support roller, and a fixed internal stylus, which engages the bore at the top. The rubber disc is driven, and causes the race to rotate slowly, a reading for squareness being obtained on the comparator through the medium of a bell-crank stylus which makes contact with the lower part of the bearing race bore.

Drive to the rubber roller is taken through a universal-jointed shaft from a small geared motor, separately mounted at the rear of the base plate. To facilitate loading and unloading the work, the bracket carrying the roller shaft, and a lever retracting mechanism, is arranged to pivot upwards, clear of the table. Two sizes of instrument are made, one for checking races from 17 to 80 mm. (0·669 to 3·15 in.) and the other for races from 40 to 120 mm. (1·575 to 4·724 in.) diameter. It is stated that races can be checked at the rate of 330 to 600 per hour.

CAMSHAFT CHECKING MACHINE

VEB Feinmesszeugfabrik Suhl have also introduced the machine illustrated in Fig. 10, for checking camshafts up to 40 in. long, as used, for example, in motor car engines. The camshaft to be inspected is loaded between headstock and tailstock centres with the aid of built-in retractable V-supports, and it is rotated at a slow speed by means of a small geared motor. Readings for accuracy of cam form are obtained by means of a sensitive electric gauge head in contact with the horizontal arm of a bell crank lever, the vertical arm of this lever being fitted with a stylus point which bears on the cam surface. The lever is pivoted in a cradle which can slide transversely under the control of a large-diameter master cam, mounted on a shaft at the rear, the latter being driven from the headstock at the same speed as the workpiece.

Any inaccuracies of the cam form on the shaft being tested are thus detected by the electric gauge head, and are clearly displayed by coloured lights on the circular panel seen at the rear. A gauging signal is transmitted after each 15 deg. of camshaft rotation, and there are two circles, each comprising 24 signal lamps. The lamps in the outer row are green, and indicate plus errors, and those in the inner row, red for minus errors. If the cam form at the particular point being checked is correct, a white light appears in the centre of the panel. The specified tolerance for error of cam form can readily be set on the gauge head. In addition, a precision dial gauge, actuated by the bell crank stylus lever, indicates the actual amount of error at any point.

The electric gauge head and cradle assembly can be traversed longitudinally along guideways on the bed by means of a motor-driven lead screw, and after the stylus has been retracted from the work, by movement of a hand lever, depression of a push-button causes the assembly to index to the next cam position, and stop automatically. A detent on the headstock is then released to allow the work to be indexed angularly, to bring it into phase with the master cam, in preparation for checking the next cam form. Independent angular adjustment, by means of micrometers, is provided for both the workpiece and the master cam, for initial setting purposes. Provision is also made on this machine for checking the diameter and concentricity of the camshaft journals, by means of dial gauges mounted on the baseplate. It is stated that the 12 cam forms of a camshaft for a 6-cylinder engine can be checked in 20 min., whereas previously, by conventional methods, the operation required about five hours.

Gauging and inspection equipment made by VEB Feinmesszeugfabrik Suhl is now being sold in this country by Mortimer Engineering Co., 204 Acton Lane, London, N.W.10.

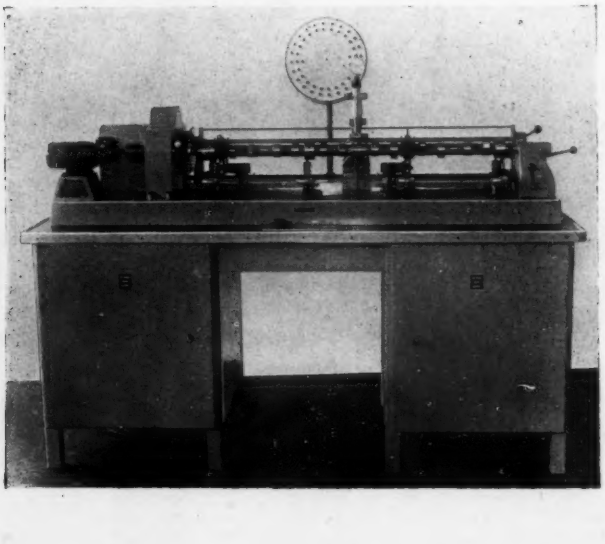


Fig. 10. Suhl Testing Machine for Camshafts up to 40 in. Long

Recent Investigations into the Blanking and Piercing of Sheet Materials*

By R. TILSLEY, A.M.I.Mech.E.,† and F. HOWARD, A.M.I.Mech.E.‡

Unfortunately, little is yet known of the mechanism of plastic flow and fracture in blanking or piercing operations, despite the fact that these operations have been standard industrial practice for many years.

Recent investigations into some of the factors affecting these operations are here described, and attempts are made to link this work with the requirements of the press-work engineer.

MECHANISM OF SHEAR

An indication of the possible mechanism of shear when blanking circular components from strip material is provided by a recent metallographic study of sections taken through the sheared surfaces.

Observations were made on ⅜-in. thick soft copper and ¼-in. thick mild steel strip. Using an open-fronted crank press equipped with a conventional design of blanking tool, a number of partially blanked specimens was prepared from 2-in. square pieces of both materials, the press ram being adjusted in order to obtain various amounts of punch penetration into the material. A die of 1 in. bore and two punches of 0·995 in. diameter and 0·950 in. diameter were used. Subsequently, metallographic sections and micro-hardness surveys were made of the deformed metal in the partially-blanked specimens.

The macro-sections for the soft copper blanked with the 0·995-in. diameter punch (Fig. 1), show that during the initial stages of punch penetration there is no sharply defined region of shear. However, the pronounced curvature which developed on the underside of the blank and the top surface of the stock, together with the fact that the punch had already entered the material, implied that large plastic flow had occurred. With increased punch penetration, a narrow elliptical region of intense deformation developed between the two edges. A micro-hardness survey along the line of shear indicated that work hardening was considerable throughout the elliptical zone.

Fig. 1 also shows that cracks formed in the material after the initial penetration, travel along the perimeter of the elliptical work-hardened region. In the last stage of punch penetration, the crack is arrested, the process thereafter continuing in shear through the outer, or stock side, or the hard elliptical region.

When mild steel was blanked with the 0·95-in. diameter punch, the resulting flow was very similar to that of copper, as described above.

Fig. 2 shows macro-sections of the mild steel blanked with the 0·950-in. diameter punch. The resulting clearance of 0·025-in. per side is comparable with that used in current industrial practice. Once again, the type of flow is similar to that for soft copper, but in this case the crack is able to travel without interference along the periphery of the elliptical zone, resulting in an inclined sheared surface without any circumferen-

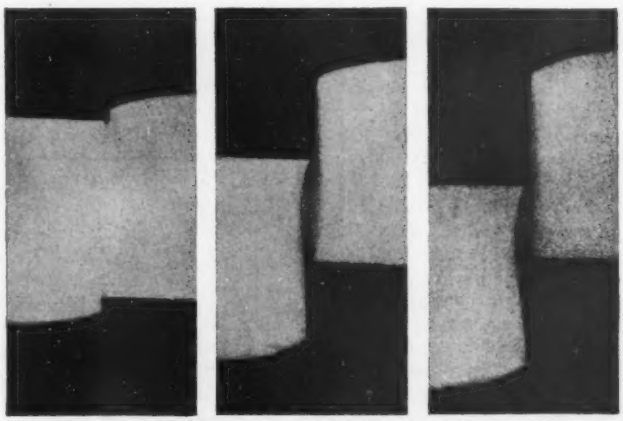


Fig. 1. Macro-sections of the Region of Deformation, at Different Stages of Penetration, when Blanking 0·375-in. Thick Soft Copper with a Clearance of 0·0025 in. per Side. Magnification 3X

* Abstract of a paper presented at the Conference on Technology of Engineering Manufacture arranged by the Institution of Mechanical Engineers.

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‡ Senior Research Engineer, Production Engineering Research Association.

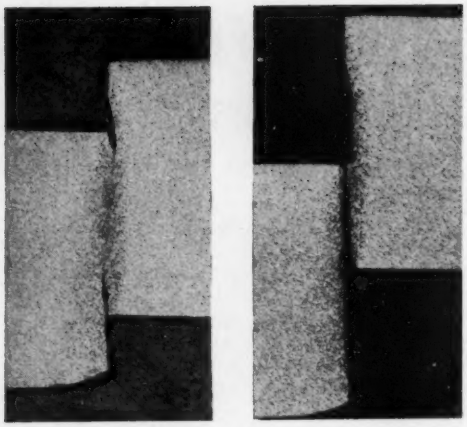

Fig. 2. Macro-sections of the Region of Deformation, at Two Stages, when Blanking 0·25-in. Thick Mild Steel with a Clearance of 0·025 in. per Side. Magnification 6 X

tial ridges (Fig. 7) of the type normally obtained when the clearance between the punch and die is small.

CLEARANCE BETWEEN PUNCH AND DIE

Some interesting information on punch and die clearance was provided by a series of tests involving the punching of 1-in. diameter holes in mild steel, stainless-steel, brass, and aluminium alloy. The nominal thickness of each material was $\frac{1}{16}$ in., and six different clearances between the punch and die were obtained by using six punches of varying size with the same die. The accompanying table shows the punch sizes used and the resulting clearance.

The work was carried out on an open-fronted crank press equipped with a specially-designed blanking tool and a capacitance dynamometer for measuring the blanking force. A diagram of the blanking tool and dynamometer, which were built into a standard two-pillar die-set, is shown in Fig. 3.

DIMENSIONS OF TEST PUNCHES AND THE CLEARANCE BETWEEN EACH PUNCH AND A DIE OF 0.9996-IN. BORE

Punch No.	Diameter, in.	Clearance per side between punch and die	
		Percentage of material thickness	In.
1	0·9993	0·234	0·00015
2	0·9968	2·19	0·0014
3	0·9942	4·22	0·0027
4	0·9878	9·22	0·0059
5	0·9758	18·36	0·0119
6	0·9508	38·12	0·0244

Fig. 4 shows the relationship between blanking force and clearance between the punch and die. With each of the four materials, the blanking force decreases almost linearly as clearance increases.

The relationship between stripping force and clearance between the punch and die is shown in Fig. 5. For each material, the minimum stripping force occurs when the clearance is approximately 20 per cent of the material thickness per side. Although the stripping force is less than 3 per cent of the blanking force when using clearances between 10 and 30 per cent, it increases rapidly with clearances outside this range, except for aluminium alloy, with which clearances in excess of 20 per cent do not result in a substantial increase in stripping force.

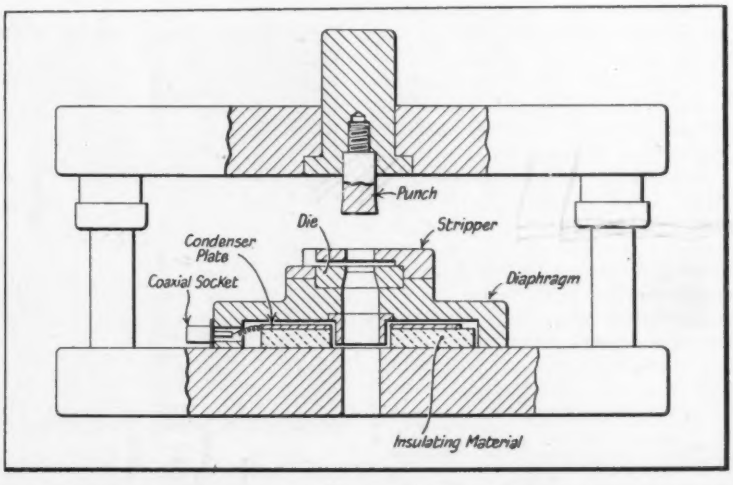

Fig. 3. Section of Tool and Dynamometer Employed for Investigating Blanking and Stripping Forces

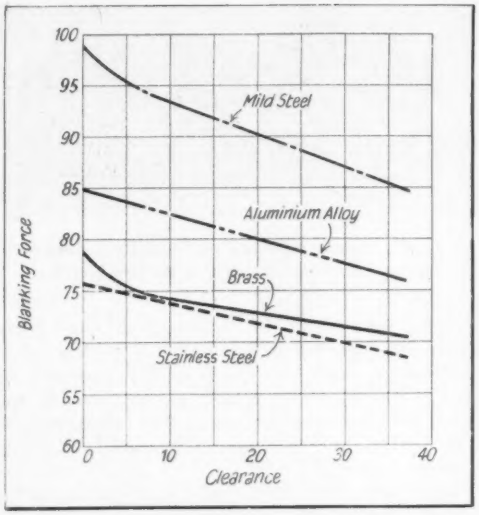

Fig. 4. Curves Showing Relationships Between Blanking Force, Expressed as a Percentage of Ultimate Tensile Strength, and Clearance for Side, Expressed as a Percentage of Material Thickness

Examination of the sheared surfaces for each of the six clearances, when blanking brass, indicated that there was little change in the condition of these surfaces with clearances up to 10 per cent of the material thickness. The surfaces were reasonably square and no appreciable burr was raised. With clearance in excess of 10 per cent, however, the surfaces became increasingly distorted. The sheared surface condition of the mild steel, stainless steel and aluminium alloy was found to be similar to that of brass.

It may therefore be concluded that, for general purposes, a clearance between the punch and die of 10 per cent of the material thickness, per side, will give a satisfactory sheared surface condition without requiring excessive blanking and stripping forces. Recent industrial experience has, in fact, indicated that punch life can usefully be extended when the punch and die clearance is increased from 5 to 10 per cent of the material thickness per side. This improvement is attributed mainly to the reduced stripping force, which probably results in reduced wear on the flanks of punches.

ANGULAR SHEAR OF CUTTING EDGES

In conneetion with blanking and piercing operations, the term "shear" is usually employed to denote the grinding of either the punch or die cutting-face obliquely to the face of the material to be sheared (the opposing cutting face in each case being parallel to the face of the material), so that shearing takes place gradually along the punch or die periphery, thus reducing the peak shearing load.

A method of calculating the approximate effect of shear on blanking force has been developed, which indicates that the force is approximately halved when using tools provided with "shear" equivalent to the material thickness.

SPEED OF BLANKING

The speed at which the blanking operation is carried out is an aspect which does not appear, as yet, to have been investigated. Although information is available on the effect of speed in tensile, compression, and torsion tests, it is difficult to apply any of this information to the blanking operation in the absence of a satisfactory strain analogue.

Industry is continually seeking reduced operation times, and blanking presses capable of operating at speeds of 1,000 strokes per min. are now available. It is possible that even higher speeds may be employed in the future, especially if it can be shown that such speeds have a favourable effect on the mechanism of shear.

In this connection, the work of Zener (1948) is of interest. In collaboration with Holloman and Van Winkle, Zener demonstrated the difference between "static" and dynamic loading when per-

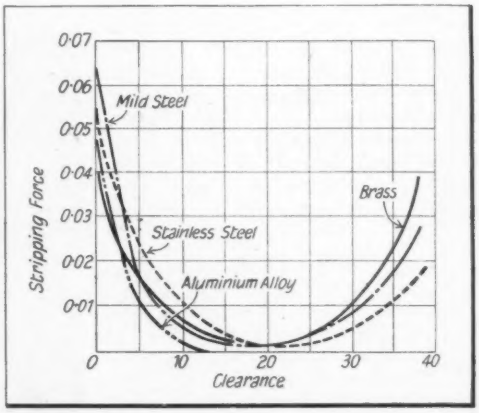

Fig. 5. Curves Showing Relationships Between Stripping Force, Expressed as a Percentage of Ultimate Tensile Strength, and Clearance per Side, Expressed as a Percentage of Material Thickness

forating steel plate with a sharp-edged punch (Fig. 6). With "static" punching, plastic deformation was general and the blank was badly distorted, whereas with dynamic punching, deformation was concentrated in a smaller area, and a much better quality blank was produced with comparatively little distortion.

Very recently, some work has been carried out by a number of aircraft companies in the U.S.A. into the use of punches propelled by high explosive for piercing high-strength materials such as stainless steel and titanium alloys. It has been claimed that clean holes can be pierced in sheet material of 250,000 lb. per sq. in. tensile strength, without cracking the surrounding metal. It is not clear, at the moment, just how explosive punching compares with more conventional methods, but it would certainly appear to offer promise, particularly for high-strength materials.

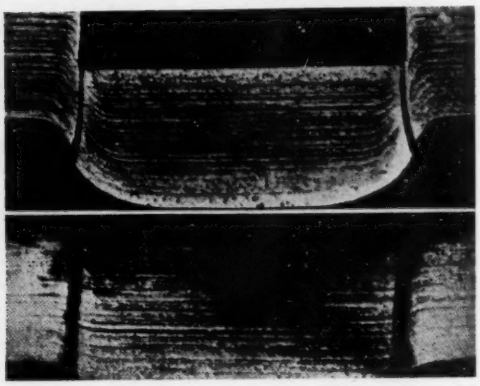

Fig. 6. Perforation of Steel Plate by a Sharp-edged Punch (Zener—1948)

FINISH BLANKING

On some blanked components, such as cams, gears and electrical contacts, a good finish is frequently required along the sheared surface. With thin components it is usually possible, by decreasing the clearance between the punch and die to about 2 per cent of the material thickness per side, to obtain a sheared surface which is reasonably square and free from cracks. With thicknesses of material greater than 0·125 in., however, decreasing the clearance between punch and die seldom gives completely satisfactory results. The sheared edge usually consists of burnished bands at the top and bottom of the blank, between which there may be one or more deep circumferential cracks or tongues as seen in Fig. 7.

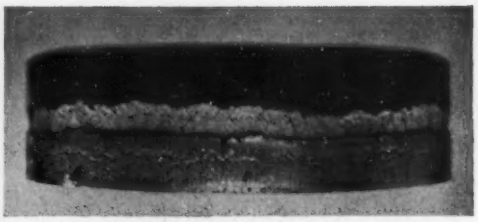

Fig. 7. Typical Sheared Edge Condition Obtained with Small Clearance and a Sharp-edged Die

One method of obtaining a good finish on the sheared surface, is to follow the initial blanking operation by a shaving operation, at which a small amount of material is removed from the surface by forcing the component through a sharp die, which is smaller than the component by about 0·010 to 0·020 in. Sometimes, two or more such shaving operations may be required in order to achieve the desired finish. Unfortunately, this procedure is not particularly economical since it involves additional handling times. Moreover, the component usually has to be individually fed to the shaving die, with the result that it is seldom

Fig. 8. Macro-sections of the Region of Deformation, at Different Stages of Penetration, when Blanking Soft Copper with a Clearance of 0·0025 in. per Side, with a Sharp-edged Punch and a Die Radius of 0·025 in.

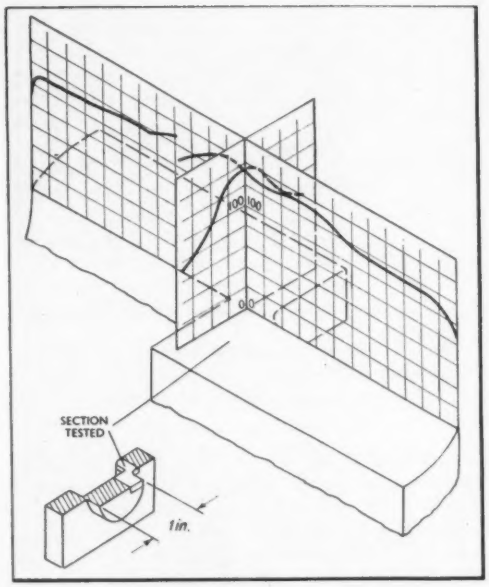

Fig. 9. A Hardness "Map" for Soft Copper at 52 per cent Punch Penetration when Blanked Through a Die with 0·025 in. Radius

possible to produce a shaved component for every stroke of a continuously-operating press, even when some form of mechanical feeding is employed.

A method of obtaining a good finish on the sheared surface at a single press operation, particularly on thick blanked components, is to employ a very small clearance between the punch and die in conjunction with a small polished radius at the die mouth in place of the normal sharp cutting-edge. This method appears to have been used first by the watchmaking industry for the production of non-ferrous parts, but no information about die radius or clearance has apparently been published. It was realized that this method, if suitable for ferrous as well as non-ferrous materials, would have numerous industrial applications. A programme of research was therefore initiated to investigate the advantages and limitations of the process (now referred to as "finish blanking") and to provide reliable data on clearances and radii which could be used by industry.

On an open-fronted crank press, equipped with a tool for blanking 1-in. diameter components from 2-in. wide strip material, tests were initially carried out on $\frac{3}{16}$-, $\frac{1}{4}$-, and $\frac{3}{8}$-in. thick aluminium and copper, each in the soft and hard tempers. The blanking tool incorporated a dynamometer for the measurement of blanking force.

A metallographic examination was made of sections through the shear surfaces of partially-blanked specimens, and typical sections of the soft copper are shown in Fig. 8. Whereas the mechanism of shear was characterized by the propagation of an open crack when using a square-edged die (Fig. 1), no such crack was evident in any of the specimens blanked through a radiused-edged die. Metal flow was continuous around the die radius at all stages of the operation, and the metal between the tool edges was very highly strained during the last part of the punch movement.

Micro-hardness tests throughout the region of shear indicated that, as with the square-edged die, considerable work-hardening of the metal had taken place. With the square-edged die, this hardened metal is broken away during the operation, but in the case of the radius-edged die the hard metal is restrained at the sheared surface. This retention of hardened metal may be an advantage in many instances, where the product is required to have a wear-resisting surface.

A typical hardness "map" for the soft copper, when blanked through a die with a radius of 0·025 in., is shown in Fig. 9.

Contrary to normal expectations, the presence of a radius in place of the normal sharp cutting edge on a blanking die has little effect on the blanking load. The effect of die radius on blanking force for hard and soft copper and soft aluminium is shown in Fig. 10.

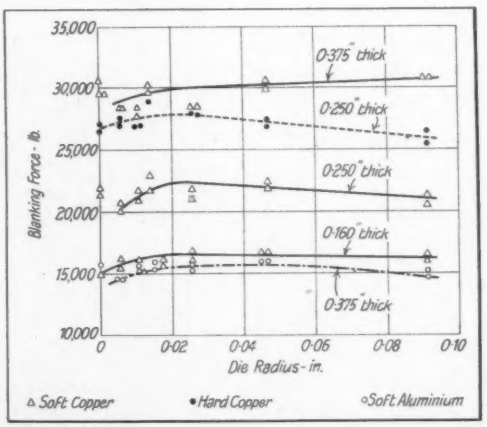

Fig. 10. Curves Showing the Effects of Die Radius on Blanking Forces for Various Materials. The Die Diameter was 1 in., and the Clearance per Side, 0·0005 in.

It will be realized that the "finish blanking" technique cannot be applied successfully in every instance. The component must possess sufficient rigidity to withstand the lateral or radial pressure on its sides, and lack of rigidity will result in dishing. Fig. 11 shows the amount of dishing on 1-in. diameter copper specimens blanked through dies of various radii. With the soft copper, the dishing increased continuously with die radius, whereas the hard copper blanks remained substantially flat until a radius of 0·025 in. had been reached.

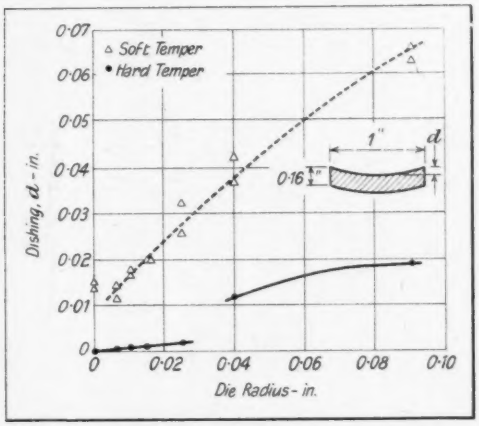

Fig. 11. Curves Showing the Effects of Die Radius on Dishing for 0·16-in. Thick Copper. The Clearance was 0·0005 in. per Side

The effect of die radius on taper on the sides of blanks is shown in Fig. 12. The taper, which was invariably very small, was found to decrease with increasing die radius for the hard materials, whereas for the soft materials little variation was detected.

The type of sheared surface condition that can be obtained when finish-blanking aluminium and copper is shown in Fig. 13. To achieve a finish of this order, it was found that clearance between the punch and die should

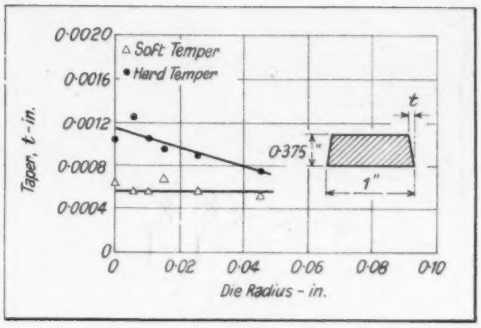

Fig. 12. Curves Showing Effects of Die Radius on Taper for 0·375-in. Thick Aluminium. The Clearance was 0·00025 in. per Side

not exceed 0·001 in. per side for all thicknesses of material investigated, and should be smaller if possible. The minimum die radius necessary to ensure a good sheared surface condition on aluminium and copper appears to vary between 0·010 in. and 0·030 in. depending on the condition and thickness of material, shape of component, and other factors. Increases in die radius above the minimum required to give a crack-free sheared surface do not have any effect on the edge condition, but tend to increase the dishing of the component.

More recent investigations have shown that straight-carbon and even alloy steels can be satisfactorily finish-blanked to give a sheared surface condition which is at least comparable to, and

Fig. 13. Aluminium and Copper Slugs for Impact Extrusion Produced by Finished Blanking

in many cases better than, that obtainable by shaving.

A selection of steel components which have been produced in industry by the "finish blanking" technique, on the basis of information recently provided by this research, is shown in Fig. 14. With most of these components, substantial economies have resulted from the elimination of shaving, and other auxiliary operations, previously required to obtain the desired quality and finish on the edges of the parts.

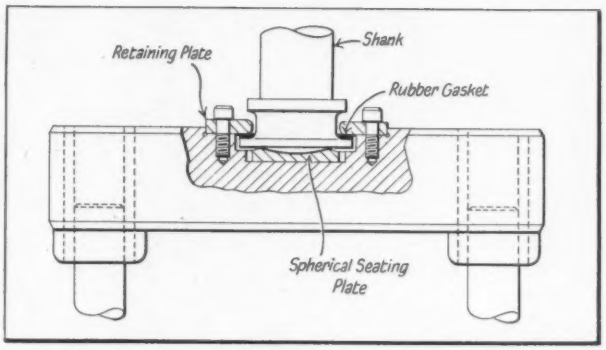

Fig. 15. Flexible Coupling for Connecting the Upper Member of a Die Set to the Ram of a Power Press

POWER PRESSES AND TOOLING

For many years, the C-frame type of crank press was used almost exclusively for light and medium blanking and piercing operations. For high-speed production, however, this type of press is now gradually being replaced in industry by the modern high-speed-blanking press equipped with strip-feed mechanism.

Whilst the C-frame type of press has a very accessible die space, and may also be used for various press-work operations such as blanking, forming and deep drawing, the frame will usually deflect under load and this deflection may sometimes alter the inclination of the slideways in relation to the bed of the press. If the upper portion of the press-tool is rigidly attached to the ram, as appears to be normal practice, any angular deflection of the slideways and ram, which may momentarily occur when a load is exerted, will be transferred to the tool, and if deflection is severe this may result in the punch hitting the side of the die. Tie-rods fitted to this type of press help to reduce, but not entirely to eliminate, this adverse deflection.

Some observations of deflection were recently made in an industrial press shop by means of a high-speed camera capable of operating at 3,000 frames per sec. These observations showed, for example, that a 40-ton C-type frame press, when operating near its maximum rated capacity, deflected sufficiently to cause the piercing punch to become misaligned by 0·016 in., relative to the die, at the moment of impact. Deflections of this order can result in greatly reduced tool life.

In many cases, a complicated blanking tool is built into a precision die-set with good static alignment between the punch and die and is then rigidly fixed in a C-frame press which, owing to its load-deflection characteristics, may impair the good work of

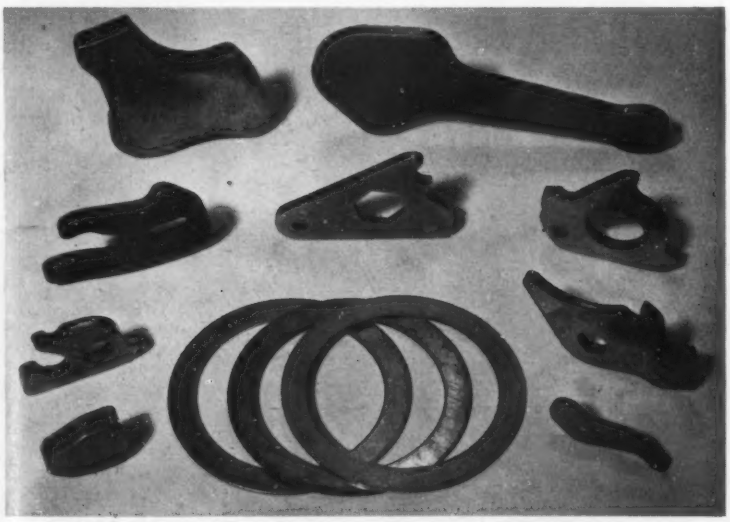

Fig. 14. A Selection of Commercial Steel Components Produced by Finished Blanking

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the toolmaker. If a precision blanking tool must be used in a C-frame press, a simple flexible coupling between the top of the die-set and the ram of the press (Fig. 15) will ensure that the press is only used to transmit reciprocating motions to the tool, the alignments then depending on the accuracy of the die set.

Ideally, however, a complicated blanking tool should be used in a power press of straight-sided construction. These presses are usually more expensive than the C-frame type, but are generally capable of operating at higher speeds and are particularly suitable for continuous strip feeding.

In connection with the increasing application of modern high-speed blanking presses, brief mention should be made of cemented carbides, which are now gradually coming into use for press tools. The main advantage of carbide for punches and dies, as compared with some of the more conventional tool steels, is the improved resistance to wear which permits longer production runs between tool grinding operations.

At the moment, experience with carbide punches and dies is limited, and it is not always easy to specifiy the most suitable grade for any particular application. It is hoped that a series of life tests, now in progress, in which various tool steels are being compared with various types of cemented carbide when punching holes in mild steel, stainless steel, and silicon laminated steel, will help to provide some guidance to industry in this matter.

During the discussion on this paper, Mr. J. C. King (English Electric Co., Ltd.) requested information on the tool life of "finish blanking" tools. In reply, the authors stated that, providing the technique was correctly applied, the life of such a tool was comparable to that of a conventional type. In one instance, when operating on ⅛-in. thick steel, some 900,000 parts had been produced. The face of the punch had been re-ground three times, and it had only been necessary lightly to stone the radius on the die.

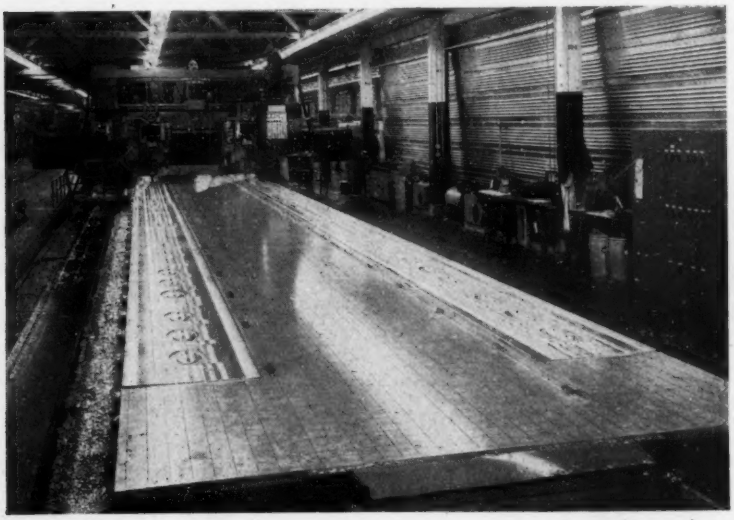
ACKNOWLEDGEMENTS

The authors wish to thank the Director and Council of the Production Engineering Research Association for permission to publish this paper, also various colleagues for assistance with the experimental work.

Kearney & Trecker Skin Milling Machine

The Kearney & Trecker skin milling machine shown in the accompanying illustration, which has a capacity of 12 by 80 ft., has recently been installed in one of the factories of the Boeing Aircraft Co., U.S.A. Arranged for magnetic tape control, the machine is seen set up for producing, simultaneously, two integrally-stiffened wing skin panels for the B-52G Stratofortress. It is stated that the panels are among the longest components of this type yet produced.

Electronically-controlled machines are now employed extensively by the Boeing Co. and at the Wichita factory there are three skin mills, three profile mills, and two automatic riveters.



Kearney & Trecker Tape-controlled Skin Milling Machine, of 12- by 80-ft. Capacity, Set Up for Machining Boeing Wing Skin Panels

Machining Facilities at the Works of Routing, Ltd.

During recent years, the rapidly expanding firm of Morfax, Ltd., Willow Lane, Mitcham, Surrey, have been engaged in the production of contoured workpieces, often of complex shape, from light alloy billets or stretched plate, by a routing process which was originally developed for woodworking, but is now fully established, subject to certain limitations, for efficient shaping of various metals by means of a rotating cutter guided along a path determined by a full-size template. The demands on the routing service provided by the company reached a stage at which is appeared desirable to form a separate organization to specialize in this field. Accordingly, a subsidiary firm, known as Routing, Ltd., was established at Faggs Road, Feltham, Middlesex, and here an extensive shop has been equipped for operations on spars, booms, wing panels and other parts for the aircraft industry. The 20 routing machines installed, all of which were supplied by Wadkin Ltd., include three fitted with heads of 20 h.p., one with hydraulic depth control, and another, which is manipulated by two operators, for handling plates of exceptional length and up to 6 ft. wide. In Fig. 1 is shown a Wadkin overhead template routing machine, employed for sculpturing large components. We may also note that nine additional routing machines are scheduled for early delivery. These machines will be of various types with spindle speeds up to 18,000 r.p.m., and heads rated at 12 or 20 h.p.

Fig. 2. Cylindrical Cutter with Four Tungsten-carbide Blades Employed for a Routing Operation

Fig. 1. Wadkin Routing Machine With Overhead Template Set Up for Operations on a Large Light Alloy Component

Good facilities are provided for the production of the metal templates on which the accuracy of the finished work largely depends.

Fig. 3. Disc-type Cutter with Six Tungsten-carbide Inserts, Employed for a Slotting Operation Between Lugs on a Light-alloy Bulkhead Component For a High-speed Aircraft

This work is undertaken in a section equipped with various machines including Smart & Brown and Colchester centre lathes; Jones & Shipman tool and cutter grinders; Victoria milling machines; and a Bohner & Koehle vertical boring machine provided with optical setting equipment by Hilger & Watts. There is also an inspection department which is engaged solely in viewing and measuring the components produced.

Experience which has been gained by the parent company in the technique of routing, and particularly in the design of cutting tools and work holding fixtures, is made available to Routing, Ltd., who are thus able to concentrate on production. An example of a special tool produced for machining a gap between two opposed lugs on a bulkhead component for a high-speed aircraft is shown in Fig. 3. The cutter takes the form of a steel disc, in the periphery of which there are six equally spaced slots, each containing a tungsten-carbide tooth, brazed in position. On account of the high rotational speeds at which the cutter is used, it is carefully balanced in the interests of stability and safety. Another cutter, employed for profiling other parts of the bulkhead mentioned above, is illusrated in Fig. 2. This cutter has four equally spaced vertical slots in which tungsten carbide blades are secured by brazing. A sliding collar of known diameter, fitted on the driving spindle above a cutter of this type, is held in contact with the reference edge of the template, and is traversed along the contour by pressure applied to the cutter head by the operator. By fitting a

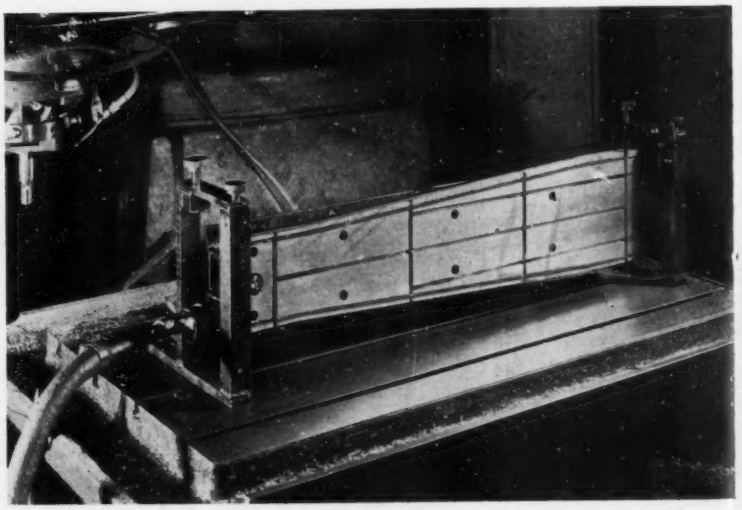


Fig. 4. Vacuum Chuck Designed by Morfax, Ltd., for Holding Components During Routing Operations

succession of collars, of progressively smaller diameters, the amount of material removed at successive passes of the cutter can be controlled. Spindle speeds range from 3,000 to 24,000 r.p.m. and are varied to suit the material being machined. It is interesting to note that the bulkhead shown in Fig. 2 weighed 8¾ cwt. when finished, whereas the billet from which it was machined weighed 23 cwt.

The problem of holding wing panels or other components on a work table during routing operations is overcome in some instances by the use of vacuum chucks, an example of which is shown in Fig. 4. An O-section sealing ring, embedded in a groove, encompasses the rectangular pattern of slots cut in the machined face of the fixture. The workpiece is held against this sealing ring while the air trapped in the space between its under-side and the machined surface of the chuck plate is evacuated, through a hose connected to an exhauster unit. The vacuum applied suffices to hold the workpiece rigidly in position during the routing operations.

Coolant is applied on the various routing machines in the form of mist which is released through jets close to the cutters. Diluted soluble oil, employed for this purpose, is contained in a pressure vessel which is placed near a machine, and the air supply to the coolant jet is taken from the shop line.

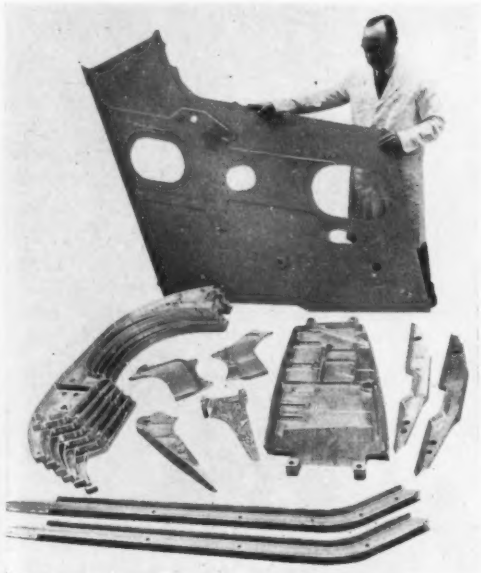


Fig. 5. Examples of Aircraft Components Produced from Solid Billets or Plates of Light Alloy on Wadkin High-Speed Routing Machines

Fig. 6. Removing Surface Blemishes from a Skin-milled Wing Panel by means of Vacu-Blast Equipment

When components have been shaped by routing to the required dimensions, tool marks and other surface blemishes are removed by barrel finishing or abrasive blasting, an application of the latter process being shown in Fig. 6. The operator is seen moving the blast gun over the surface of a skin-milled wing panel which, it may be noted, has areas of different thickness blended by chamfers at the edges of the contoured layers in order to avoid abrupt changes in the section of the material. Fine abrasive grit, which impinges against the surface of the work over a restricted area, governed by the diameter of the blast gun head, is returned to the grit container, after use, through a vacuum hose which is concentric with the delivery hose. The grit and metallic dust are separated in a unit which forms part of the equipment.

Some other components machined from the solid are illustrated in Fig. 5. The skin-milled panel at the rear is representative of much of the work undertaken by Routing, Ltd., who have produced many similar panels from light alloy sheets ¼ in. thick and up to 12 ft. long by 4 ft. wide, the metal in certain areas being removed to leave a skin thickness of only 0·080 in.

(*Continued on page* 170)

Chemical and Petroleum Engineering Exhibition

The first Chemical and Petroleum Engineering Exhibition, organized by F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2, in collaboration with the British Chemical Plant Manufacturers' Association and the Council of British Manufacturers of Petroleum Equipment, was held recently at Olympia. There were nearly 300 exhibitors, and displays included wide ranges of tools and equipment for use in the oilfields and in refining crude oil, also for producing chemicals such as sulphuric acid, carbon dioxide, and chlorine.

Lark air-operated hand motors for use with high-speed steel and tungsten-carbide burrs were displayed on the stand of H. Williams & Son, Ltd., Sandridge Road, St. Albans, Herts. These motors are available with spindle speeds from 10,000 to 75,000 r.p.m., and can be fitted with collets to take burrs with shanks of 3, 4, 6, and 8 mm. and ⅛, $\frac{3}{16}$, and ¼ in. Oberg burrs and rotary files, Compac and Parvus dial gauges, and examples of Lark tube-cleaning equipment were also shown. Tube bending machines of hand-operated, motor-driven, and hydraulic types were exhibited on the stand of Hilmor, Ltd., Caxton Way, Stevenage, Herts, together with examples of cold-bent tubes up to 4½ in. diameter in steel and 6 in. diameter in non-ferrous metals.

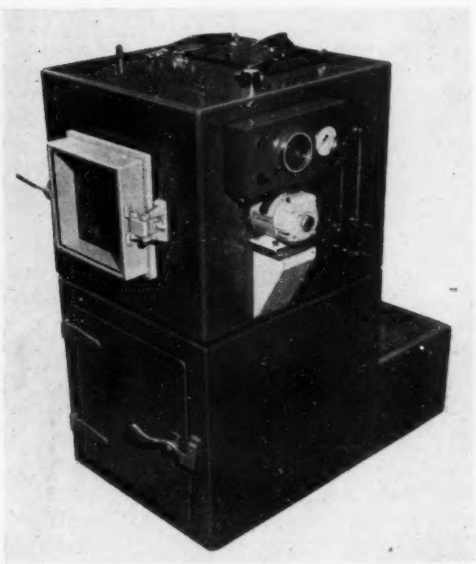


Fig. 1. Fairey Chamber for Testing Small Components and Mechanisms at Temperatures from 100 to 60 deg. C.

Exhibits of the Fairey Aviation Co., Ltd., Hayes, Middlesex, included the temperature test chamber shown in Fig. 1. Originally designed for testing, under conditions of heat and cold, the behaviour of small components and mechanisms used in the firing equipment of guided missiles, the unit incorporates a stainless-steel chamber of 1 ft. cube, which can be rapidly brought to—and accurately maintained at—temperatures from 100 to −60 deg. C. Heating is effected electrically by a 1-kW. element, and cooling is brought about by the circulation of trichlorethylene whereby the heat is transferred to solid carbon dioxide. Another exhibit was a Fairey multi-purpose analogue computer, which is of compact, unit construction, and can be employed, for example, for solving problems associated with the design of servo mechanisms, and for the solution of sets of non-linear differential equations connected with heat-flow problems. Solutions may be indicated on cathode-ray oscillographs, direct-writing instruments, and X-Y plotters, to suit requirements.

On the stand of Henry Wiggin & Co., Ltd., Birmingham, 16, were displayed parts made from the company's nickel alloys such as Corronel B, Ni-o-nel, Incoloy, and Nimonic, and these served to demonstrate the forms, including sheets, extrusions, forgings, and castings, in which the materials are available.

Representative of the wide range of equipment presented by Wm. Gardner & Sons (Gloucester), Ltd., Bristol Road, Gloucester, for mixing, sifting, drying, and grinding, sand, plastics moulding powders, carbon black, and asbestos, for instance, may be mentioned a 14-ft. diameter stainless-steel double-cone type mixer for the plastics industry, and an 8-in. diameter unit for laboratory use. Also on view was a Gardner band conveyor fitted with a 4-speed reversing gearbox and a magnetic clutch.

Demonstrations of Hicycle portable electric tools which operate on 3-phase supplies of 200 cycles,

125 volts were given on the stand of the Consolidated Pneumatic Tool Co., Ltd., 232 Dawes Road, London, S.W.6. The Hicycle range includes drilling units with capacities from $\frac{3}{16}$ to 2 in. diameter, screwdrivers, nut-runners for bolt sizes up to $\frac{1}{2}$ in. diameter, tappers for threads up to $\frac{5}{8}$ in. diameter, impact wrenches, and grinders. For cleaning welds, for example, in places difficult of access, the grinders are available with spindle extensions from 8 to 33 in. and speeds from 11,760 to 5,650 r.p.m. Reference may be also made to Lagonda tube cleaning equipment which is made under licence by the company for cleaning straight and curved tubes from $\frac{3}{8}$ to 6 in. diameter. The equipment comprises air-driven motors to which different heads fitted with brushes and conical cutters, of a variety of types, are attached. Consolidated compressors on show included the new type FE of horizontal balance-opposed design. The unit is made with two and four cylinders of various sizes, and outputs up to 5,000 c.f.m., F.A.D., and pressures up to 3,000 lb. per sq. in. are obtainable.

Lake & Elliot, Ltd., Braintree, Essex, displayed a number of castings in carbon, heat- and corrosion-resisting steels, and in iron, which had been produced and machined to close limits in their works. In addition to a well-equipped machine shop, the firm has a comprehensively-appointed inspection department for testing castings by gamma radiography, and by magnetic-particle, fluorescent-dye, and ultrasonic methods. Machined steel castings were also shown by the National Steel Foundry (1914), Ltd., Kirkland Works, Leven, Fife, who, in recent years, have extended their foundry and have installed all-electric melting equipment. Machining facilities for batch production and individual parts are available.

Panels, fume ducting, and deep-drawn parts, in Stelvetite laminated p.v.c.-steel were featured on the stand of B.X. Plastics, Ltd., Higham Station Avenue, London, E.4. The company supplies the p.v.c. material used in the manufacture of this composite sheeting, which is carried out by John Summers & Sons, Ltd., Shotton, Chester.

In Fig. 2 is illustrated the Lincolnweld type M.L.2 submerged-arc hand welding equipment and associated remote control unit, which was demonstrated on the stand of the Lincoln Electric Co., Ltd., Welwyn Garden City, Herts. With this control arrangement, which was described in MACHINERY, 91/556—6/9/57, the current control switch on the generator is set to a maximum value and adjustments are then made by a knob on the remote control unit, with reference to an ammeter. The display also included examples of the company's type B.11 automatic submerged arc welding heads, Arcair cutting and gouging equipment, the Remotrol unit for use with Lincoln arc-welding generators, and the SAE 300 diesel engine-driven generator set, some of which were demonstrated.

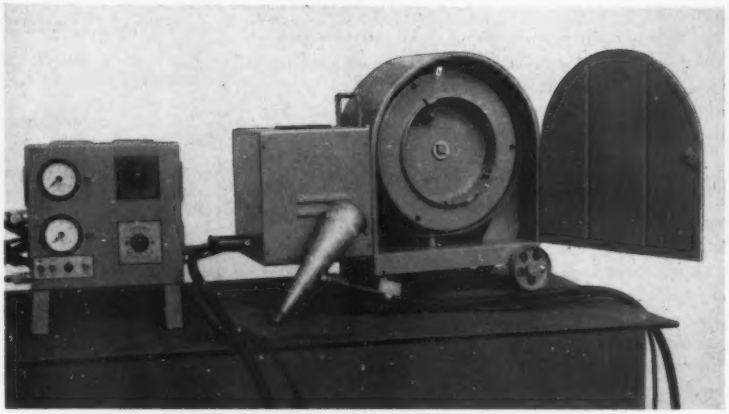


Fig. 2. Lincolnweld Type M.L.2 Submerged-arc Hand Welding Equipment and Associated Remote Control Unit

Quasi-Arc, Ltd., Bilston, Staffs, staged demonstrations of various welding electrodes including the Celtian cellulose iron-powder type for use on pipelines, the Ferromax, the Mirrospeed, and the Ceromoid No. 5 which is intended for joining dissimilar metals. Reference may also be made to Lynx equipment for shielded inert-gas metal-arc welding of non-ferrous alloys, corrosion- and heat-resisting steels, and mild steel. A comprehensive range of equipment for metal-arc welding was also exhibited by Murex Welding Processes, Ltd., Waltham Cross, Herts.

Among other exhibitors the following may be mentioned: Accles & Pollock, Ltd. (tubing); Air Pumps, Ltd. (air compressors and vacuum pumps); Audley Engineering Co., Ltd. (compressed air valves for pressures up to 5,000 lb. per sq. in.); Birlec, Ltd., Dryer Division, Erdington, Birmingham, 24 (furnace atmosphere generators); British Ermeto Corporation, Ltd. (valves, couplings, and

Simplifix joints); Coventry Gauge & Tool Co., Ltd. (Matrix taper thread plug and ring gauges); Deloro Stellite, Ltd. (demonstrations of the spray-fusing process for hard-facing metal components with Stellite); K. & L. Steelfounders & Engineers, Ltd. (steel castings, and Jones mobile cranes); Langley Alloys, Ltd. (Langalloy 20V austenitic alloy steel); Murex, Ltd. (tungsten carbide tipped tools, milling cutters and dies); Tilghman's, Ltd. (Bohler pneumatic tools); Vacu-Blast, Ltd. (shot blast machines); Charles Wicksteed & Co. (1920), Ltd. (tube expanding equipment); T. Boorn & Co., Ltd. (Dynalink all-metal flexible couplings); and William Boulton, Ltd. (Vibro Energy mill for grinding materials to sub-micron sizes).

Newman Industries Demonstration

Newman Industries, Ltd., Machine Tool Division, Yate, Bristol, recently staged a demonstration of Continental machine tools, for which they are sole selling agents in the United Kingdom, at the storage depot of Sivewright Transport & Storage, Ltd., Platts Works, Trafford Park, Manchester.

Of particular interest was the Heid Neomat type VK.56 copying lathe, with variable centre height, which is believed to be the only copying centre lathe yet built with this feature. The lathe admits 10 ft. between centres and has a variable centre height from 15¾ to 22¼ in., so that an increase of nearly 50 per cent in diameter capacity can be obtained over the full turning length, also for surfacing. It was demonstrated copy turning a piston connecting rod 9 ft. long and weighing 1½ tons.

Copying through 180 deg. is obtained by means of an electro-magnetic tracer which follows the contours of a master or template. The template holder accommodates four templates so that four cuts can be taken successively by indexing through 90 deg. It may be noted that the cutting forces always fall within the bedways, resulting in a fine finish and less stress on the machine. In a later issue we hope to publish a more detailed description of this machine, which is approximately 18 ft. long and weighs 9 tons.

Other machines and equipment demonstrated included the Heid Sensitast type K.18 copying lathe, which was seen machining shafts for the Newman Electric Motor Division; a Pfeifer type F.60 horizontal boring and milling machine; a Technoimpex type UF.22 universal milling machine; a TOS type BPV.300 vertical spindle hydraulic surface grinding machine; a Heid planer-drive unit and multi-disc clutches; and a centre lathe computer, designed to assist time study and planning engineers in making rapid calculations for centre lathe work.

Trade Publications

THE INCANDESCENT HEAT CO., LTD., Cornwall Road, Smethwick, Birmingham. Leaflet No. V26a gives brief particulars of the company's standard gas-fired furnaces which can be supplied with work chamber dimensions from 12 by 12 by 9 in. to 48 by 36 by 18 in.

THE SILVAFLAME CO., LTD., 218a Monument Street, Birmingham 16. Illustrated brochure giving details of the wide range of Cleervue guards made by this company. The range includes guards for bench drills, radial drilling machines, vertical and horizontal milling machines, capstan lathes and other units.

THE GRESHAM GROUP OF COMPANIES, Gresham House, Feltham, Middlesex.—Fully-illustrated booklet covering the activities and products of the Group. This publication has been compiled for the purpose of increasing export sales, and the contents are printed in English, French German, and Spanish.

SELF-CHANGING GEARS, LTD., Lythalls Lane, Coventry. Booklet entitled "Brief History of Self-Changing Gears, Ltd., and the Wilson Gearbox" which traces the development and use of the Wilson gearbox from the first car to which it was fitted (in 1901) to its many applications at the present day.

THE REX HACKSAW & TOOL MFG. CO., LTD., Albion Way, Exhibition Grounds, Wembley, Middlesex. Series of illustrated leaflets describing the steel clothes lockers, shelving, racks and bins, also the Rex 7½- and 10-in. heavy-duty hack-sawing machines, made by this firm. Other leaflets are devoted to the company's facilities for the production of steel pressings and irregularly-shaped mild steel blanks.

E. N. MASON & SONS, LTD., Arclight Works, Colchester. Folder giving brief particulars of the A4000 series of Allbrit drafting machines which are available in forms suitable for vertical or steeply inclined boards, and for horizontal or slightly inclined boards. Another publication shows how Mason and Mason Minor drafting tables can be conveniently employed in conjunction with Arclight sliding-top reference units.

W. E. BURNAND & SON, LTD., Duo Works, 66-106 Shoreham Street, Sheffield, 1. Fully illustrated catalogue describing the Phoenix circular and bi-pole lifting magnets. The former are available in sizes from 24 to 77 in. diameter with maximum lifting capacities, depending on the nature of the material, from 11,200 to 67,200 lb. Bi-pole magnets can be supplied for cold or hot lifting and are intended for handling billets, ingots, rails, and similar metal sections. Typical installations are shown, and particulars of magnet control gears and cable coiling drums are included.

B. & S. MASSEY, LTD., Openshaw, Manchester. Catalogue 5900H, which replaces 4600H, describes, with numerous illustrations and specifications, the company's range of "Clear Space" pneumatic power hammers. These hammers range in size (weight of falling parts) from 2 to 40 cwt. Another publication, No. 5800H (replacing 4800H) is concerned with pneumatic power hammers with slides, and attention is drawn to the various features of design. Hammers of this type are available in sizes (weight of falling parts) from 1 to 10 cwt.

News of the Industry

Yorkshire

TOM SENIOR, Hightown, Liversedge, still finds it necessary to work overtime to meet the demand for precision horizontal milling machines equipped with 25- by 6½-in. tables. In addition to the home trade, a good export business is being done with Commonwealth and European countries. A batch of these machines was recently sent to the U.S.A., and further orders are in hand. The call for attachments and accessories, such as dividing heads, rotary tables, vertical milling and slotting attachments, and adjustable aluminium milling cutter guards is well maintained. A range of the firm's products is to be shown at the forthcoming Model Engineer Exhibition to be held at the New Horticultural Hall, Westminster, from August 20 to 30.

THE CRESCENT ENGINEERING CO., LTD., Hightown, Liversedge, are steadily occupied on a variety of sub-contract orders for machine tool components and sub-assemblies, also for equipment for the confectionery trades. Other work in hand includes Finny tap nose lead grinders, which are built for Tap Sharpeners, Ltd., Cheadle Hulme, Stockport. We hope to describe one of the latest of these machines in the near future.

THE R. J. H. TOOL & EQUIPMENT CO., LTD., Artillery Street, Heckmondwike, report a well-maintained demand for grinding and polishing machines of various types. Orders in hand cover double-ended pedestal grinders, fitted with abrasive wheels of 10, 12 and 14 in. diameter, combined grinding and polishing machines, Bandfacers, backstand machines, backstand idlers, Unipol abrasive-band polishers, and carbide tool grinders. New features are being incorporated in the Bandfacer, to which further reference will be made, and backstand machines on order include wide belt and twin speed types. Canada, South Africa and India are the principal export markets. The accessories department is experiencing an active call for surface plates, including grade A types, swivel angle plates, straightedges and suds pumps.

RELIANCE TRUCKS, LTD., Heckmondwike, are engaged on home and export orders for petrol- and diesel-engined trucks, tractors and trailers, of various types and sizes, and including fixed- and elevating-platform trucks, tipping vehicles, and fork-lift types.

DOUGLAS BARNES, LTD., Hollinbank Lane, Heckmondwike, are well employed on the production of a variety of fabricated steel components, which include machine tool beds, woodworking machinery bodies, bedplates, and gearboxes. On the machine side, work in progress includes press brakes up to 8-ft. by ½-in., and plate bending rolls up to 8-ft. by ⅜-in. capacity. The latest addition to plant is a Pearson ½-in. guillotine shearing machine, and a recently-installed planing machine will accommodate work up to 12 ft. long by 3 ft. square.

T. S. HARRISON & SONS, LTD., Union Works, Heckmondwike, have a good order book for their 5- and 6-in. centre lathes, and 13½-in. swing lathes, specially developed for the American markets. Hydraulic copying equipment is being provided on some of these machines. We may also note orders for 8-in. centre lathes, with and without copying equipment, a number of which are destined for the U.S.A. For copy-turning, this lathe is fitted with a 10-h.p., 2-speed reversing motor. There is a brisk demand for 5-in. centre wood-turning lathes for training schemes, also for 6-in. centre wood-turning lathes of the industrial type. The range of equipment available for use on these machines has been considerably extended.

Other active lines at these works include double-ended pedestal grinding machines, equipped with abrasive wheels of 10, 12 and 14 in. diameter, heavy-duty machines with wheels of 18, 20 and 24 in. diameter, tool and cutter grinding machines, and bench- and column-type 4- and 8-speed vertical drilling machines. In the equipment section, orders are well maintained for surface plates, swivel and box angle plates, bench test centres, and other accessories. Overseas destinations of the firm's products include U.S.A. and South America, Australia, New Zealand, South Africa, India, Israel, Holland, Denmark, Spain and Portugal. Office extensions have recently been completed, and various additions have been made to the machine tool equipment. In the works we noted that extensive use is being made of Brooke unit heads, in the tooling equipment for the latest-type machines, for drilling, boring, reaming and milling operations.

WM. HARDILL, SONS & CO., LTD., Cleckheaton, report some reduction in demand for their various types of wood-working machines, including wood-turning lathes, 4-cutter planing and moulding

machines, bandsaws, and saw benches, from both the home and export markets. The call for cast-iron and wrought-iron pulleys, including conveyor pulleys and all-steel welded pulleys, is maintained at a steady level, but quieter conditions are being experienced in both the general and repetition foundries.

HENRY CROWTHER & SONS, LTD., Cleckheaton, have some capacity available for the production of turned shafting, in sizes from 1 to 6 in. diameter and in lengths up to 24 ft.

KITCHEN & WADE, LTD., Arundel Street, Halifax, have recently added to their range of products a precision-type vertical "drill boring" machine on which the table movements are motorized. It is intended to bridge the gap between the conventional vertical drilling machine and the toolroom type jig boring machine, and is suitable for drilling, boring, tapping, facing and chamfering operations. The machine avoids the need for jigs and marking-out on medium batch work. Table positions can be read directly from large diameter dials to 0·001 in., and, where greater accuracy is required, tracks are provided to receive measuring rods and dial indicator gauges which give readings to 0·0005 in. We hope to describe this machine more fully in due course.

DAVY AND UNITED ENGINEERING COMPANY, LIMITED, Sheffield, have recently booked an order, valued at more than £1,000,000, from the Northern Aluminium Co., Ltd., for their Rogerstone works. It covers the supply of a 4-high breaking-down and plate finishing mill, which will form part of a £10,000,000 expansion programme to increase the rolling capacity at these works from 50,000 to 75,000 tons of aluminium strip and sheet per annum.

H. B.

The Midlands

F. B. H. DURACHROME, LTD., Factory Centre, Kings Norton, Birmingham, 30, report that the recently-completed extensions to their hard chromium-plating plant have increased the production capacity by 100 per cent. The addition of the latest types of vats, rectifiers, and exhausting equipment enables the hard chromium-plating of a wide variety of items to be undertaken, on a large scale. Parts treated in this manner include shafts, dies, jigs, tools, piston rods, and rams, and, in connection with the last two items, we may note that the company is plating and polishing approximately 700 per week. Other activities include the reconditioning of plug gauges, by deposition and subsequent grinding and lapping; the reconditioning of omnibus parts, such as king pins and brake camshafts, for various transport undertakings; and the treatment of various aircraft components. In the latter connection it may be noted that the company is A.I.D. approved.

DELORO STELLITE, LTD., Highlands Road, Shirley, Solihull, Warwickshire, are still very busy by reason of the sustained demand for their Stellite hard-facing service for industry. Among the many components and tools to which Stellite may be applied as wear-resistant material are forging dies, hot shear blades for the glass industry, mill hammers, high temperature steam valves, rubber extrusion screws, pump sleeves, press tools, entry guides and ploughshares. In machine shops, good results are being obtained by users of face milling cutters with inserted Stellite teeth. Stellite-tipped workplates are used on centreless grinding machines and are reported to have very satisfactory life. A good demand is also being experienced for Stellite heavy-duty parting tools and drills, the latter being employed, for example, for drilling out the cores of broken taps and drills, and for producing holes in chilled iron and other difficult materials.

J. BROCKHOUSE & CO., LTD., Elms Works, Penn Road, Wolverhampton, have extensive shops divided among several departments each engaged on specialized work. Among the activities may be mentioned machine tool building, machine tool rebuilding, sub-contract machining involving centreless grinding operations, the grinding of slideways, and jig boring work. The rebuilding department remains active and at the time of our visit various machine tools were is course of being restored to their original standards of accuracy. Frequently, old machine tools are modernized during the rebuilding process, to improve the standard of performance. A scheme is in operation whereby substitute machine tools for those under repair can be offered, on temporary loan, to customers, when production would otherwise be interrupted. The lifting facilities provided cover loads up to 8 tons.

The company's unit grinding head and truing device, which was developed as an attachment for a planing machine to facilitate slideway grinding operations, has since been employed extensively for additional work when mounted on large centre lathes and boring mills. It may be noted that the firm is A.I.D. approved.

F. E. WOODWARD, LTD., Harrow Street, Wolverhampton, are still actively engaged in the design and construction of jigs, fixtures, and special-purpose equipment for the motor vehicle industry and other branches of engineering. This firm has well equipped works with a range of modern machine tools, including a Newall 2436 jig borer.

F. W. H.

I.P.E. Report on the Control of Quality

A sub-committee of the Institution of Production Engineers' research committee has recently issued a report entitled "Quality—Its Creation and Control."

In a summary of this report, the creation and control of quality is defined as "the development and realization of specifications necessary to produce economically, and in adequate degree, the appearance, efficiency, interchangeability and life which will ensure the product's present and future market." This conception is intended to cover the entire field of manufacturing activity from design through the various production stages, and with its application, quality ceases to be the concern of the inspection department alone, but is the responsibility of all departments involved. For this reason, the committee recommends the replacement of the inspection department by a quality department, the functions of which would include "full co-operation with, and circulation of information to other departments, as well as the essential verification and audit of quality of the finished product."

It is pointed out that the quality department should have equal status with other major departments, and be responsible to the senior executive concerned with all activities of the production organization. The committee recognizes that liaison between design, production and quality departments may take considerable time to develop, and will vary in nature in different firms, but emphasizes that it is important for such liaison to provide up-to-date information on the ability of existing and proposed processes to produce work of the required quality. It is considered essential that the approval of the quality department should be obtained for shop lay-out arrangements, operational planning with particular reference to inspection, and the design of all inspection and testing equipment. On the other hand, since the quality department is responsible for the acceptance of finished products, it should be given the opportunity of checking and approving work from new machines and plant, in order that performance may be assessed before the equipment is released for production duties. Advantage should be taken of information provided by the department on current levels of quality obtained from each item of equipment, for making arrangements for maintenance work to be undertaken with the minimum interruption of production.

In connection with the control of quality on the shop floor, attention is drawn to the importance of providing facilities whereby components may be checked by the operator of a machine during the working cycle, or immediately after its completion. Reliably and effectively carried out, such a system eliminates the need for subsequent inspection, and affords an opportunity for corrective action to be taken as soon as defective work is produced. This procedure, termed Operator Control, is recommended with the object of encouraging pride of workmanship by placing responsibility for quality on the operator rather than the inspector.

New Monks & Crane Stock Rooms

To provide improved facilities for the distribution of engineers' small tools in the Bristol area, South Wales and the West of England, Monks & Crane Ltd., Garretts Green Lane, Birmingham, 33, recently opened new offices and stock rooms at 9 Stokes Croft, Bristol (telephone number, Bristol 9-4331), where a representative selection of twist drills, reamers, taps, dies and other tools is available for immediate supply. With the opening of the Bristol branch the company now has, in addition to its head office, six regional distribution

A View in the New Bristol Premises of Monks & Crane, Ltd. Showing Storage Arrangements for Small Tools

centres the others being located in London, Leeds, Manchester, Newcastle-on-Tyne, and Glasgow.

The occasion of the opening of the Bristol branch was celebrated by a reception at the Grand Hotel, Bristol, to which guests from many sections of industry were invited by the directors of the company.

Part of the storage accommodation for tools is shown in the accompanying illustration.

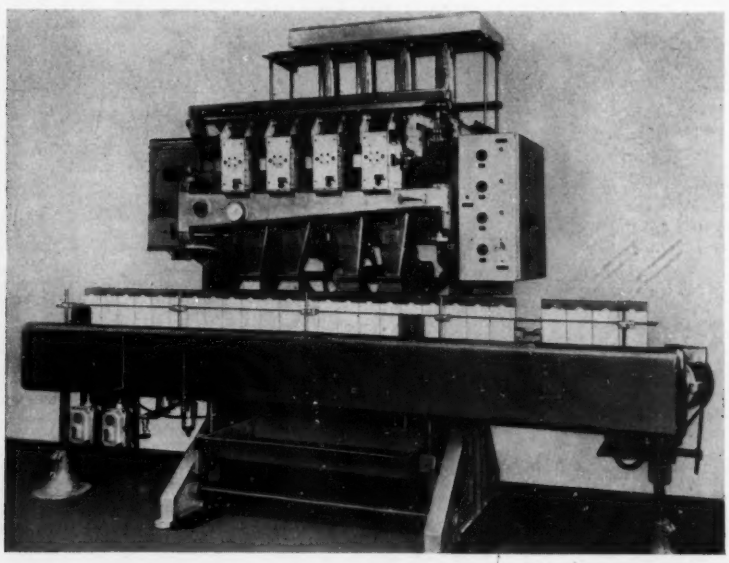
"Pneumatic Scale" Machines

A company has been formed with the title Pneumatic Scale (England), Ltd., to build and market the complete range of "Pneumatic Scale" packaging and bottling machinery. "Pneumatic Scale" machines have been supplied to the packaging industry since 1895, when the company was first founded in Quincy, Mass., U.S.A., by William H. Doble. Since that time, more than 100 types of machines for packaging and bottling have been designed. Many of them are fully automatic and provide for outputs up to 300, cleaned, filled, capped and labelled containers per min.

The production of machines will be undertaken at the works of Vickers-Armstrongs (Engineers), Ltd., including automatic packaging equipment for handling most types and sizes of cartons and other containers. Among these items we may note the Velocitron high-speed packager, Rotapax continuous motion packing machines, Duplex heat seal and Rotorex pouch making and filling machines, dustless power fillers for powder products, and Duo-Vac and Vacuflow powder drum and bottle fillers.

"Pneumatic Scale" equipment is already used extensively by manufacturers in this country, and a typical machine—a 4-head Pneumatron net weigher—is shown in the figure.

Sales and servicing of both British- and American-built equipment will be handled by Rockwell Pneumatic Scale, Ltd., Welsh Harp, Edgware Road, London, N.W.2, to whom all enquiries should be addressed.



The 4-head Pneumatron Net Weigher which is Included in the "Pneumatic Scale" Range of Packaging Machines

Fair of Industry and Commerce

The first British Fair of Industry and Commerce, at Belle Vue, Manchester, was opened by the Lord Mayor of Manchester, Ald. James E. Fitzsimons, on July 4. The exhibition, which is sponsored by Belle Vue (Manchester), Ltd., and organized by Mr. J. I. Sandler, Advertising Publications Ltd., Sunderland, will remain open each weekday until Saturday, July 19, from 11 a.m. to 9.30 p.m. There are about 150 exhibitors, representing a wide range of industries, and among a number of engineering firms, we may note the following.

ALLSPEEDS, LTD., Oakenshaw Works, Clayton-le-Moors. — A selection of variable-speed gear units, which give 9 to 1 stepless speed variation, and cover a range of from 1/33 to 15 h.p.

BRAYSHAW FURNACES & TOOLS, LTD., Belle Vue Works, Manchester. —The new Hynor gas-heated furnace, which has a temperature range from 650 to 1,200 deg. C., without the use of forced air, also a selection of milling cutters, and a radius grinding attachment.

BRONX ENGINEERING CO., LTD., Lye, Stourbridge.—A 30-ton all-steel welded press brake, which admits 6 ft. between the columns and

8 ft. overall on the beams, and a hand-operated 8-ton press brake, for bending 24-in. wide by 16-gauge mild-steel sheets.

FURNIVAL & CO., LTD., Reddish, Stockport.—The Andantex speed-reducing pulley, incorporating planetary gears, for which they have the sole manufacturing rights in Great Britain.

SAUNDERS VALVE CO., LTD., Cwmbran, Newport, Mon.—A wide variety of diaphragm valves, spherical plug valves and centrifugal pumps.

TRIANGLE PRODUCTS, LTD., Manchester Road, Hyde.—A range of arc and spot welders, for both light and heavy duty, and with both oil and air cooling.

THORNTON-STUART WOODWORKING MACHINES, LTD., Preston, Yeovil, Somerset.—A universal woodworker, which comprises a sawbench, surface planer, boring table, and spindle moulder, and can be offered in various combinations.

H. WOOLLACOTT & CO. (GEAR CUTTERS), LTD., Trafford Park, Manchester.—Examples of spur, bevel, helical and spiral gears, chain sprockets and racks cut in their works.

Arrangements have already been made for holding the second Fair, from July 10 to 25, 1959, when a total of 160,000 sq. ft. of space will be available on one floor, and will provide for 487 stands.

Personal

MR. ROBERT YOUNG, B.E.M., has been appointed chief inspector of the Salterpak Division of Geo. Salter & Co., Ltd., West Bromwich.

MR. T. J. R. SMITH has been appointed sales manager of Hellermann, Ltd., Crawley, Sussex. He was formerly manager of the Hellermann Solderless Connectors Division at Crawley.

SIR ALEXANDER SIM has been appointed chairman and director of Henley Foundries, Ltd., Banners Lane, Cradley, Cradley Heath, following the retirement of Sir John Dalton, M.I.E.E., F.C.I.S.

MR. J. BARRY YOUNG, 104 Percy Street, Newcastle-upon-Tyne, has been appointed technical representative of Charles Baynes, Ltd., in the North-East Coast Area.

MR. GEORGE BUTLER, A.M.I.Prod.E., chief designer of the Butler Machine Tool Co., Ltd., Mile Thorn, Halifax, has been appointed to the board of directors. He has been with the company for 30 years and is well known in the machine tool industry in Great Britain, Canada, U.S.A., and on the Continent.

Mr. G. Butler

MR. D. A. HARLEY has been appointed commercial manager to Anderton Springs, Ltd., Clyde Street, Bingley, Yorks.

DR. P. RODERICK has been appointed assistant chie metallurgist to the Steel Division of the Steel Company of Wales, Ltd., and will work in collaboration with Dr. Baldwin, who holds a similar position.

MR. F. GORDON KAY, A.M.I.Mech.E., has been appointed to the board of Acheson Colloids, Ltd., 18 Pall Mall, London, S.W.1. He was formerly manager, sales relations, for the parent company, Acheson Industries (Europe), Ltd.

BRIGADIER A. LEVESLEY, a director of Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield, has been appointed president of the Sheffield and District Engineering Trades Employers' Association, in succession to Mr. Ambrose Firth.

MR. JOHN B. SHAW, sales engineer at the Huddersfield office of Brook Motors, Ltd., since 1953, has been transferred to the Leeds sales office in a similar capacity, where he succeeds Mr. H. Lumb, who will shortly be taking up another appointment with the company.

Correction

In a description of the Matrix 3-dimensional measuring machine, published in MACHINERY, 92/1416—13/6/58, it was incorrectly stated that longitudinal and transverse settings of the work table could be made to an accuracy of 0·001 in. This figure should have been 0·0001 in.

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16/7/58

Industrial Notes

MASSEY-FERGUSON, Coventry, inform us that their telephone number has been changed to Coventry 75533.

RANSOME & MARLES BEARING CO., LTD., Newark-on-Trent, have asked us to point out that their Glasgow office has for some time been situated at 380 Argyle Street, Glasgow (telephone number, Central 3948).

MIDLAND ENGINEERING SALES AGENCIES, LTD., 385 Hagley Road, Birmingham 17, have issued a booklet entitled "Sales Efficiency in the Engineering Industry." It is in two sections, the first of which deals with the requirements of the small to medium-size manufacturer, and the second, with the services offered by the company as agents.

CAPLIN ENGINEERING CO., LTD., Beaconsfield Road, Willesden, London, N.W.10, inform us that in the interests of economy and efficiency they have absorbed the organization of their associate company Capco (Sales), Ltd. All enquiries, orders and correspondence should now be addressed to Caplin Engineering.

THE BRITISH MOTOR CORPORATION, LTD., Longbridge, Birmingham, report that their 2,000,000th vehicle for export since the war was shipped on July 1. This vehicle, one of the new 7-ton trucks, left Birmingham bound for Malaya. At the same time, the 1,999,999th, a Morris Minor, was consigned to Sweden, and the 2,000,001st, an Austin Healey Sprite, to the U.S.A.

DORMAN & SMITH, LTD., Ordsal Lane, Manchester, 5, announce that on August 3 the entire works and offices will be moved to a new factory at Preston. The head office of the associate company, D. S. Plugs, Ltd., will also be situated at Preston, although the works will remain in Cumberland. From the above date, the address of these companies will be Atherton Works, Blackpool Road, Preston, Lancs (Telephone number Preston 86785).

THE POLYTECHNIC, 309 Regent Street, London, W.1, have published a list of courses on various aspects of administration and management, to be held next autumn, among which may be noted the following: Communication in Management; Modern Incentive Schemes; Work Study; Work Study for Apprentices; Production Control and Planning; and the European Common Market. Full details of these courses can be obtained on application to the Head of Department, Mr. Frank A. Heller, at the above address.

STANLEY HOWARD, LTD., 73 Devon Street, Birmingham 7, have recently opened a new section, at their Devon Street Works, for the production of plug gauges. A stock of standard double-ended loose gauges will be available, and the company will undertake the manufacture of special gauges to customers' requirements. An additional service provides for the reclamation of worn gauges by the hard-chrome deposition process.

CITY AND GUILDS OF LONDON INSTITUTE, Gresham College, Basinghall Street, London, E.C.2.—A pamphlet (Form 2) has been issued by the Institute giving details of the main changes in the regulations and syllabi of existing subjects, and of new schemes which are being introduced in the session 1958/59. The courses affected include: iron and steel; non-ferrous metals; metal finishing; electric technicians; pattern-making and foundry practice; sheet metal work; and welding.

HEADLAND ENGINEERING DEVELOPMENTS, LTD (a subsidiary of Thos. P. Headland, Ltd., 10 Melon Road, Peckham, London, S.E.15), have formed a Gauges and Screwing Tools Division, which can supply H.E.D. plain plug gauges up to 6 in. diameter, screw plug and ring gauges for all types of threads, and high speed ground thread taps. Mr. James H. Thornton, formerly of the Guided Weapons Department, Vickers-Armstrongs (Aircraft), Ltd., has been appointed technical representative for the new division.

Machining Facilities at the Works of Routing, Ltd.

(*Continued from page* 161)

If necessary, the thickness of panels can be reduced, locally, to 0·025 in., with the equipment available.

The existing shops occupied by Routing, Ltd., are shortly to be supplemented by additional premises, with an area of 18,000 sq. ft., which are nearing completion on a nearby site. By September of this year it is hoped to occupy the new building, and the production facilities will then be substantially increased.

Experimental work on the application or routing to the production of components in titanium and high tensile alloy steels is being undertaken at the parent company's works in Mitcham on behalf of the Ministry of Supply.

Obituary

MR. LEONARD AUSTIN.—It is with regret that we report the death of Mr. Leonard Austin, in his 71st year. Until his resignation, on June 30, he was managing director of Wadkin, Ltd., Leicester. Mr. Austin joined the company as works manager in 1920, just before the building of Green Lane Works was begun, and he was largely responsible for the layout and equipment of those works.

Mr. L. Austin

He was appointed a director in 1936, and joint managing director, with the late Sir Holland Goddard, in 1948. He became managing director in 1956 when Sir Holland relinquished his executive offices.

After completing his early engineering training with Tangyes, Ltd., Birmingham, Mr. Austin moved to Halifax to take up an appointment with William Asquith, Ltd. He was a past chairman of the Leicester Branch of the Institution of Production Engineers.

Machine Tool Share Market

Stock markets generally displayed a firm tone during the period under review but quiet conditions persisted in most sections, with buying interest selective, and the volume of business small.

The gilt-edged section met with moderate but sustained investment support, and quotations for British funds and similar fixed interest stocks finished higher on balance.

While a firm undertone was maintained in the commercial and industrial sections, activity remained at a low level, and movements among prices were only small and irregular. Nevertheless a number of good features have been in evidence.

Machine tool issues held steady to firm. Broom & Wade advanced 3d. to 10s. 7½d.; Churchill Machine Tool, 3d. to 17s. 6d.; Geo. Cohen, 3d. to 12s. 3d.; Coventry Machine Tool, 3d. to 8s. 9d.; John Holroyd "A," 3d. to 10s. 6d.; Butler Machine Tool, 6d. to 6s.; John Holroyd "B," 6d. to 10s. 3d.; Samuel Osborn, 6d. to 18s.; Modern Engineering, 1s. 6d. to 10s. 6d.; and Kayser Ellison, 1s. 6d. to 46s. On the other hand, Ambrose Shardlow, lost 1s. at 37s.; British Oxygen, 6d. at 34s.; John Harper, 1½d. at 13s. 3d.; and John Shaw & Sons (Wolverhampton), 1½d. at 12s. 3d.

Abwood Machine Tools, Ltd.—Final dividend 5 per cent, making, with the interim, a total distribution of 10 per cent (same).

John Harper & Co., Ltd.—Final dividend 20 per cent, making, with the interim, a total distribution of 30 per cent.

New Companies Registered*

Bradford Metal Spinning Co., Ltd., Farnham Road Works, Great Horton, Bradford.—Registered June 23, 1958. Nom. cap.: £3,000 in £1 shares. Permanent directors: F. Moore and F. Moore, Junior.

Darflex, Ltd., Du-Al House, 5 Byron Road, Harrow.—Registered June 19, 1958. To carry on the business of manufacturers of, and dealers in, tubular steel, etc. Nom. cap.: £5,000 in £1 shares. Directors: J. Conway (managing director), G. Ross, Dr. A. Bay, L. A. Morris, P. R. Montague, M. L. Carr, B. Black, P. M. Davis and I. H. Conway.

Celtic-Swiss Precision Co., Ltd., Talport Foundry, Yniscedwyn Road, Ystradgynlais. Registered June 27, 1958. To take over the business of precision tool makers carried on as "Celtic-Swiss Precision Company" at Ystradgynlais, etc. Nom. cap.: £600 in £1 shares. Directors: W. C. Pretot (permanent director and chairman), Mrs. H. M. Morris, E. Williams, J. Wermeille, C. F. Hunt and Mrs. J. Harrhy.

* From the lists compiled by Jordan & Sons, Ltd., Company Registration Agents, 116-118 Chancery Lane, London, W.C.2.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	9d.
Armstrong, Stevens & Son, Ltd.	Ord.	5/-	8/3xd
Allen (Edgar) & Co., Ltd.	Ord.	£1	29/6xd
" "	5% Prf.	£1	14/9*
Arnott & Harrison, Ltd.	Ord.	4/-	13/6
Asquith Machine Tools Corp., Ltd.	Ord.	5/-	18/9
" " "	6% Cum. Prf.	£1	18/6
Birmingham Small Arms Co., Ltd.	Ord.	£1	28/-
" "	5% Cum. "A" Prf.	£1	15/6
" " "	6% Cum "B" Prf.	£1	17/6
" " "	4% 1st Mort. Deb.	Stk.	86/-
British Oxygen Co., Ltd.	Ord.	£1	34/-
" " "	6½% Cum. Prf.	£1	21/3
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	4/7½
Broom & Wade, Ltd.	Ord.	5/-	10/7½
" "	6% Cum. Prf.	£1	17/9
Brown (David) Corporation Ltd.	5½% Cum. Prf.	£1	14/-
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/9
Butler Machine Tool Co., Ltd.	Ord.	5/-	6/-
" " "	5% Cum. Prf.	£1	13/9
C.V.A. Jigs, Moulds & Tools, Ltd.	5½% Red. Cum. Prf.	£1	13/9
Churchill (Charles) & Co., Ltd.	Ord.	2/-	4/10½
" " "	6% Cum. Prf.	£1	26/3
Churchill Machine Tool Co., Ltd.	Ord.	5/-	17/6
" " "	6% Cum. Prf.	£1	18/6
Clarkson (Engrs.), Ltd.	Ord.	5/-	12/6
Cohen (George), Son & Co., Ltd.	Ord.	5/-	12/3
" " "	4½% Cum. Prf.	£1	14/6
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	14/3
" " "	5% Cum. Red. Prf.	£1	16/3
Coventry Machine Tool Works, Ltd.	Ord.	4/-	8/9
Craven Bros. (Manchester), Ltd.	Ord.	5/-	6/7½
Elliott (B.) & Co., Ltd.	Ord.	1/-	2/9
" "	4½% Red. Cum. Prf.	£1	13/9
Export Tool & Case Hardening Co., Ltd.	Ord.	2/-	1/3
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	12/-
Greenwood & Batley, Ltd.	Ord.	£1	48/1½xd
Harper (John) & Co., Ltd.	Ord.	5/-	13/3
"	4½% Red. Cum Prf.	£1	13/1½
Herbert (Alfred), Ltd.	Ord.	£1	33/9
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	10/6
" " "	"B" Ord.	5/-	10/3
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	21/3
" " "	7% Cum. Prf.	5/-	5/-
Kayser, Ellison & Co., Ltd.	Ord.	£1	46/-
" " "	6% Cum. Prf.	£1	18/3
Kendall & Gent, Ltd.	Ord.	5/-	7/7½
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	6/3
Kitchen & Wade, Ltd.	Ord.	4/-	10/6
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/4½
Massey, B. & S., Ltd.	Ord.	5/-	8/3xd
Modern Engineering Machine Tools Ltd.	Ord.	5/-	10/6
Newall Engineering Co., Ltd.	Ord.	2/-	4/6xd
Newman Industries, Ltd.	Ord.	2/-	2/3
" " "	6% Prf. Ord.	5/-	5/6
Noble & Lund, Ltd.	Ord.	2/-	2/9
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	18/-
" " "	5½% Cum. Prf.	£1	26/-
Pratt (F.) & Co., Ltd.	Ord.	5/-	21/3
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	5/-xd
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	37/-
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	12/3
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	33/9
" " "	5% Cum. Prf.	£1	15/-
Stedall & Co., Ltd.	Ord.	5/-	6/3
Tap & Die Corporation, Ltd.	Ord.	5/-	7/6
" " "	4½% Deb. 1961-1977	Stk.	82/-
Wadkin, Ltd.	Ord.	10/-	18/6
Ward (Thos. W.), Ltd.	Ord.	£1	76/6
" "	5% Cum. 1st Prf.	£1	15/9
" "	5% Cum. 2nd Prf.	£1	24/6
Willson Lathes, Ltd.	Ord.	1/-	2/4½xd

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

PRICES OF MATERIALS

All prices per ton except where otherwise stated.

Pig-Iron

Foundry and Forge No. 3, Class 2

Middlesbrough zone	£21 6 0
Birmingham	£20 18 3

Phos. 0·1 to 0·75%

Birmingham	£23 17 0

Scottish Foundry

Grangemouth	£25 3 6

Hæmatite English No. 1

N.E. and N.W. Coast	£25 6 6
Scotland	£25 13 0
Sheffield	£26 15 0
Birmingham	£27 4 0

Welsh £25 6 6

Steel Products

Medium plates	£45 11 6
Mild steel plates, ordinary*	£42 2 0
Boiler plates*	£44 12 0
†Flat bars 5 in. wide and under †Round bars under 3 in. Billets, rolling quality, soft U.T.	£40 0 6 £32 15 6

Phosphor Bronze

Ingots (2B8) (A.I.D.) d/d £249 0 0

Copper

Cash (mean)	£195 2 6
Cold rolled and hot rolled sheets 4 ft. by 2 ft. by 10 SWG	£262 5 0—£262 10 0
Rods ⅞ in. to 4 in. diam	£282 15 0
Tubes, 1½ in. bore by 10 SWG, ton lots, per lb.	2s. 8d.
Wire rod, black, hot-rolled (½-⅞ in.) English	£211 12 6

Zinc

Refined, minimum 98 per cent. purity, current month (mean) £62 8 9

Brass

Tubes, solid drawn, per lb.	1s. 6½d.
Strip 63/37, 6 in. by 10 SWG coils, ton lots	£219 0 0—£224 5 0
Rods, ½-3 in. diam. (59 per cent copper)	1s. 9½d.

Yellow Metal

Condenser plates, per ton	£157 0 0
Rods, per lb.	1s. 10½d.

Aluminium

Ingots min. 99·5 per cent Canadian d/d	£180 0 0

Lead

Refined, minimum 99·97 per cent purity, current month (mean) £70 2 6

Tinplates

‡U.K. Home trade:

Handmill f.o.t. makers' works	£3 11 8½
Cold reduced, f.o.t. makers' works	£3 7 4½

U.K. Export:

Hot rolled basis, f.o.t. works' port	74s. 0d.—75s. 0d.
Cold reduced basis, f.o.t. works' port	75s. 0d.

Gunmetal

Ingots, 85.5.5.5. ex works £164 0 0

* N.E. Coast, N. Joint Area, Central Scottish Zone.

† U.T. soft basic.

‡ Official maximum price, after allowing for adjustments for increase in price of tin.

MAKERS' PRICES

Hexagon Steel Bars[1]

Sizes in inches from 1 in. up to 2·21 and 2·41 a/f, ex works 2 ton basis £42 17 0

Free cutting black £47 6 6

Reeled Steel Bars[1]

Single-reeled 1½ in. upwards, f.o.t. works (+ usual extra for sizes) £43 9 6

Free cutting £47 19 0

High-Speed Steel

Black random length bar. All prices basic, per lb., subject to extras.

Molybdenum "66"	5s. 10½d.
Molybdenum "46"	5s 8½d.
14 per cent tungsten	5s. 9d.
16 per cent tungsten	6s. 1½d.
18 per cent tungsten	6s. 4d.
22 per cent tungsten	7s. 5d.
5 per cent cobalt	9s. 6d.
4·75/5·25 per cent molybdenum + 6·0/6·75 per cent tungsten + 1·75/2·05 per cent vanadium (5-6-2)	6s. 0½d.

Precision-ground, High-speed Free-turning Brass Rod[2]

½-in. dia. ± 0·00025-in. 2-ton lots, per lb. 2s. 2½d.

Grey Iron Rod

Die Cast[3] in random lengths 18 in. to 26 in. rough machined ⅛-in. above listed size. Extra for definite lengths. Discounts for orders over £150.

	Per cwt. net. Mark I	Mark III
¾ or ⅞ in.	245s. 4d.	318s. 10d.
1 or 1¼ in.	196s. 4d.	251s. 10d.
1½ to 1¾ in.	137s. 10d.	171s. 2d.
1⅞ to 2 in.	106s. 2d.	125s. 11d.
2¼ to 3¼ in.	91s. 6d.	106s. 4d.
3½ to 12 in.	86s. 6d.	99s. 2d.

Continuous Cast

10-ft. lengths, centreless machined 1 to 3-in. dia. + 0·010 to 0·020 in., prices as quoted for die cast bar[3]

6-ft. lengths centreless ground + 0·010 in. Extra for hardenable alloy iron[4] Per cwt. net	¾ or ⅞ in.	245s. 4d.
	1 or 1¼ in.	196s. 4d.
	1½ to 1¾ in.	137s. 10d.
	1⅞ to 2 in.	106s. 2d.
	2¼ to 3½ in.	91s. 6d.

Stellite[5]

Welding Rods plain

¼ in. dia. per lb. 30s. 0d.

Toolbits

¼ in. sq. × 4 in., each 22s 3d.

Precision-ground Mild Steel[2]

1-in. dia. + 0·00025-in. 4-ton lots, per cwt. 121s. 6d.

[1] Colvilles, Ltd., Glasgow, and 17 Grosvenor Street, London, W.1. [2] Pratt, Levick & Co., Ltd., Chester. [3] Sheepbridge Alloy Castings, Ltd., Sutton-in-Ashfield. [4] "Plocast," Harold Andrews Sheepbridge, Ltd., Halesowen. [5] Deloro Stellite, Ltd., Highlands Road, Shirley, Solihull.

BASIC PRICES FROM LONDON STOCK[6]

Free Cutting Steel

Bright cold drawn: (Usaspead) over 1½ to 2 in.	£59 17 6
Lead bearing (Usaled)	£64 4 0
Precision ground, 1⅜ in.	£81 12 6

Bright Drawn

M.S. bars (M.M.C.) over 1½ in. to 2 in.	£55 3 6
Square edge flats (Usaflat)	£72 0 0
M.S. angles (Usaspead)	£99 10 0
Casehardening (EN) (Usacase) over 1½ in. to 2 in.	£63 9 6
M.S. bars (EN3B) (Usamild) over 1½ to 2 in.	£57 3 6
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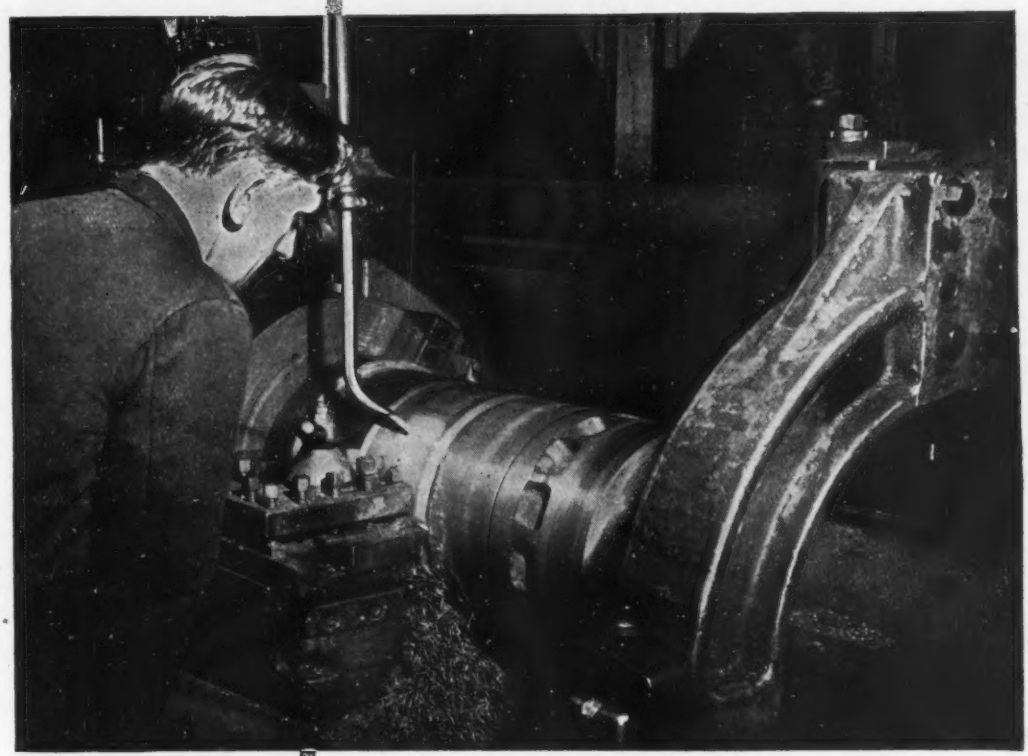

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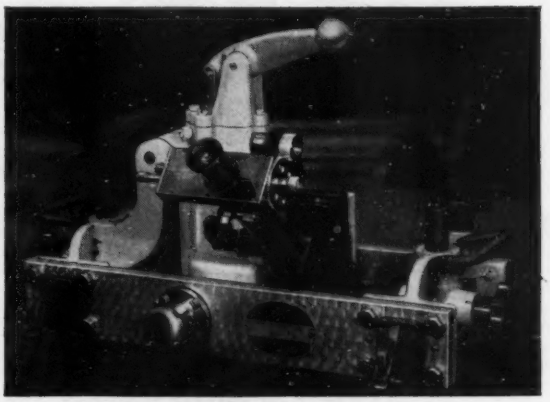

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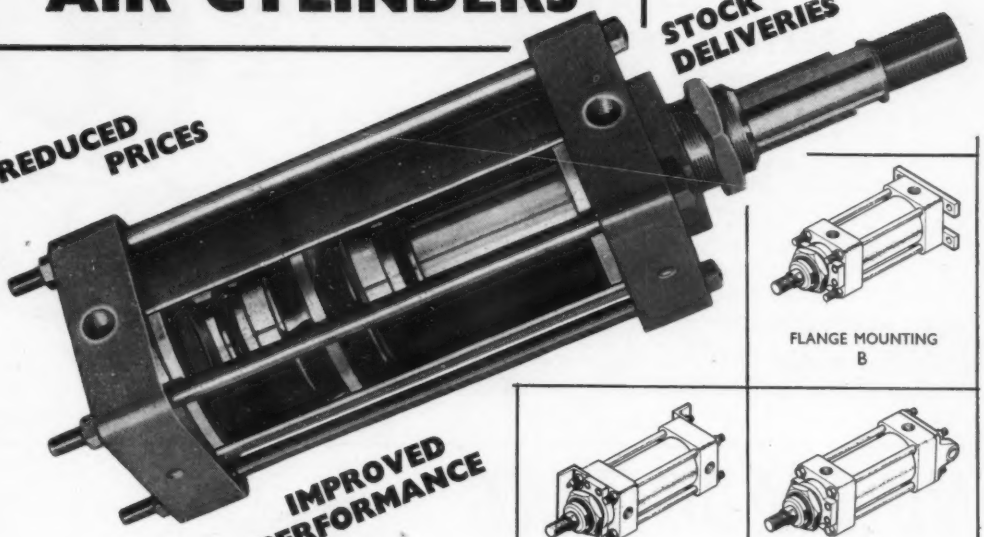

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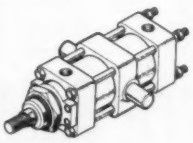

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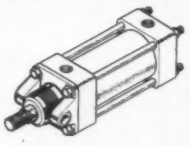

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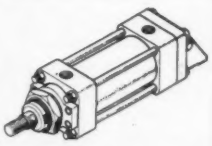

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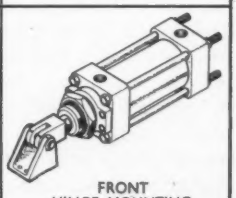

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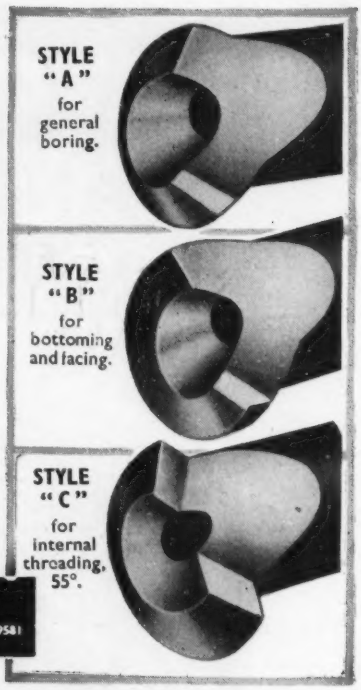

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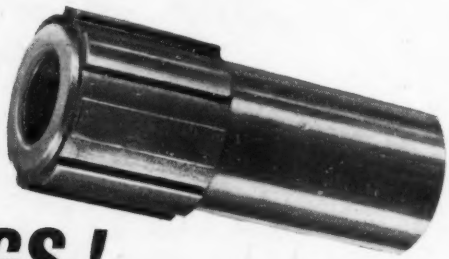

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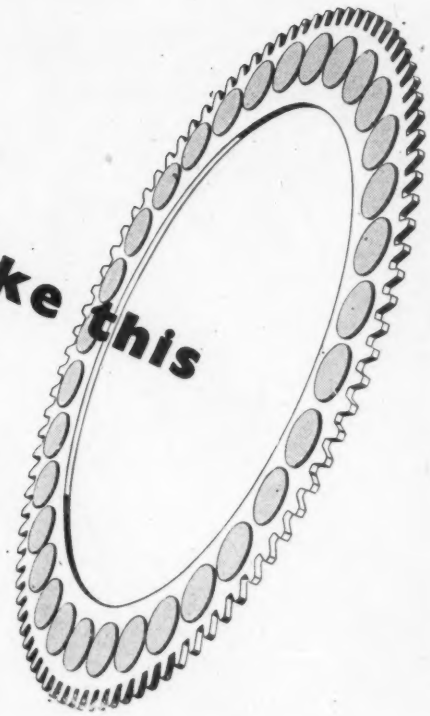
you see—it's like this



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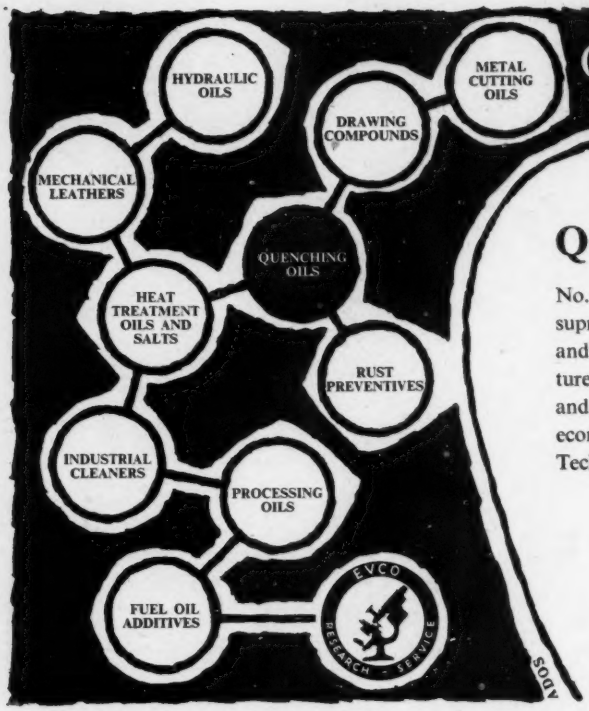

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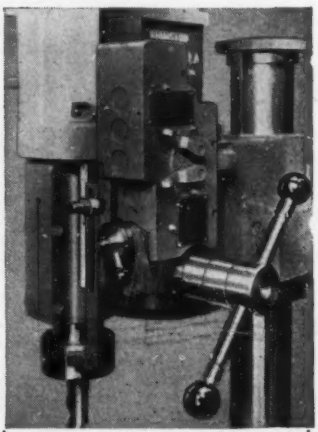

This power feed unit gives the powerful, precise ELECTRISKA extra productive capacity. Four rates of feed from 0.0035in. to 0.008in. or 0.0055in. to 0.0105in. per rev. Precision depth stop with automatic trip at any required depth. Range of machines covers bench, column and pedestal models up to 1¼in. capacity. Speeds up to 5075 r.p.m. Write for catalogue.

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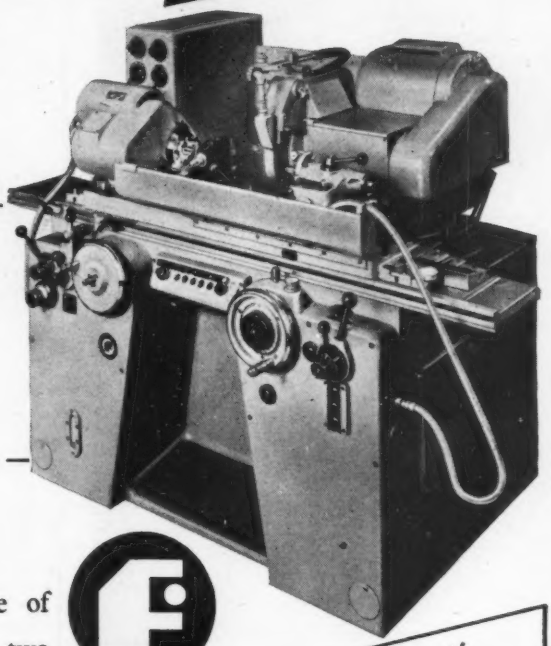

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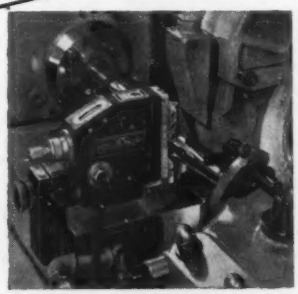

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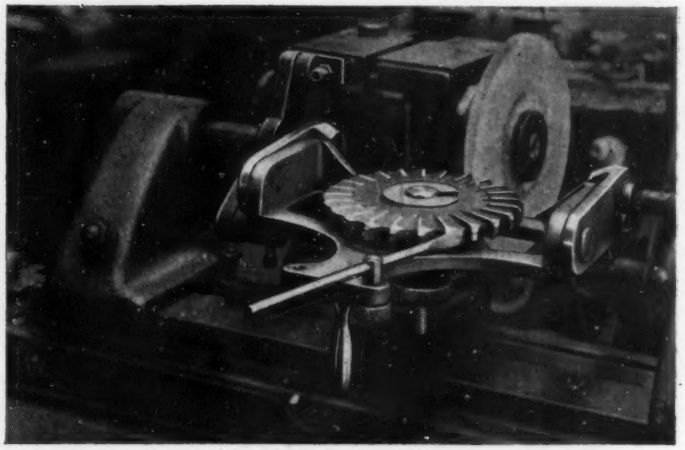
Radii ... ... Up to ⅜in.



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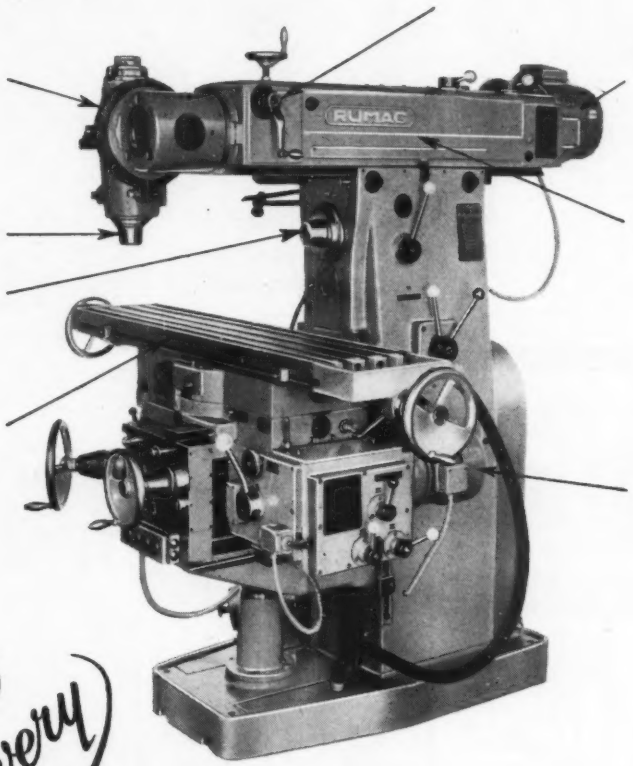

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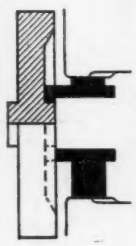
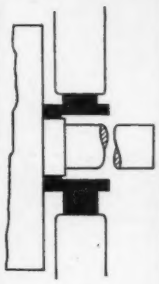
MODEL 'D'

SPECIAL ANVILS

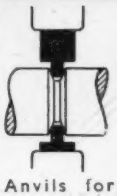


Anvils for measurement of a shoulder diameter in a recess.



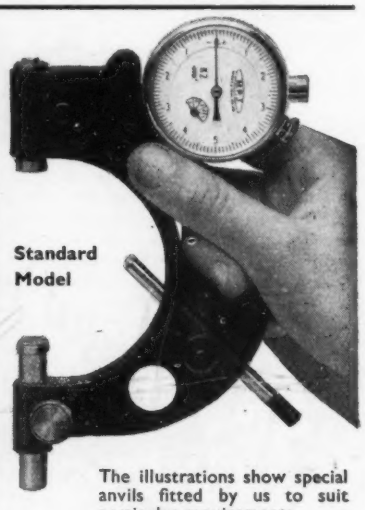
Anvils for measurement of a shoulder diameter.

Anvils for checking dimensions of a gear.



Anvils for measurement of a groove.

Anvils for measuring a root dimension of a rotor blade.



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The illustrations show special anvils fitted by us to suit particular requirements.

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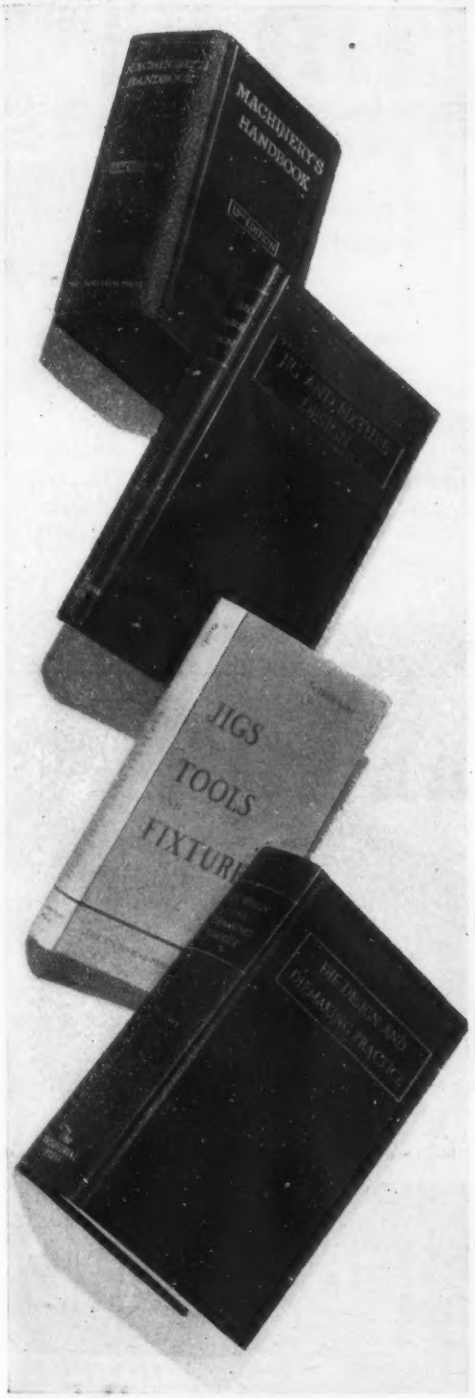

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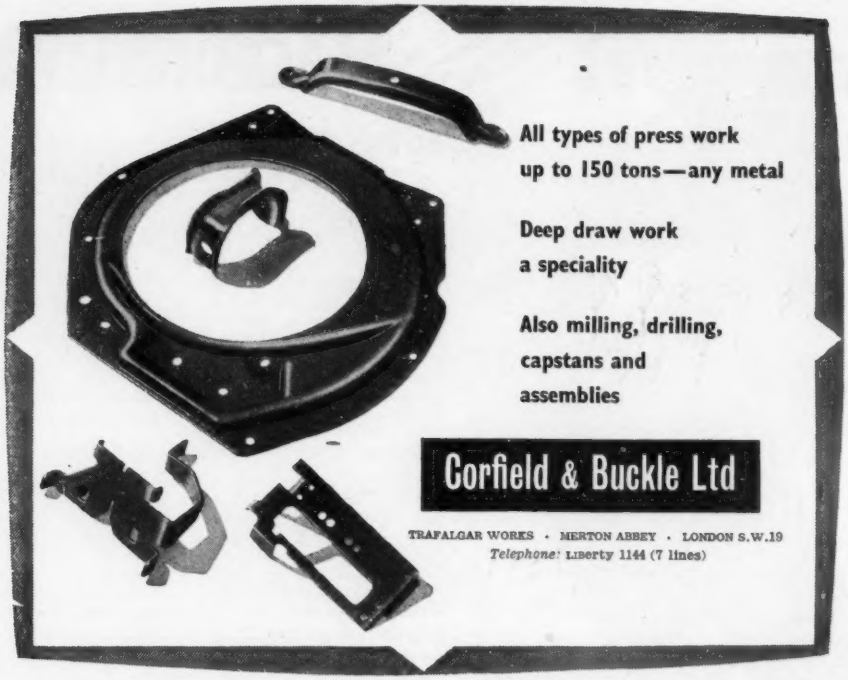

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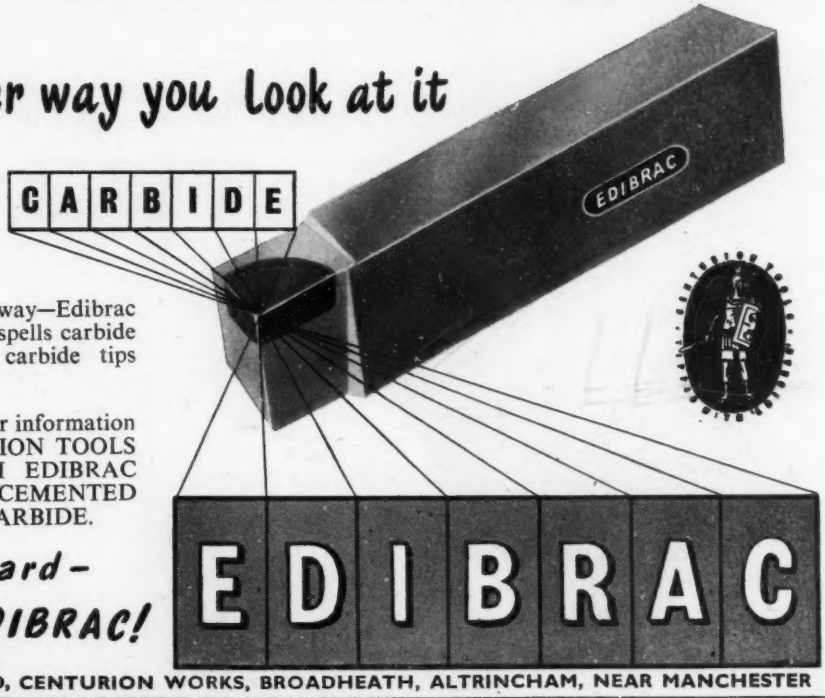

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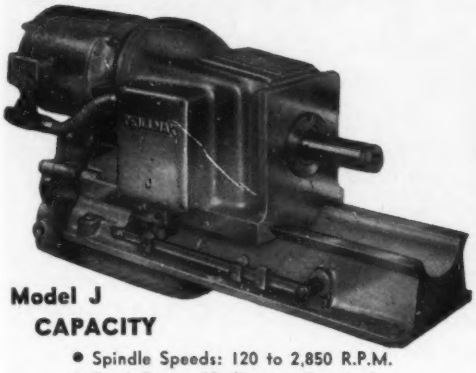

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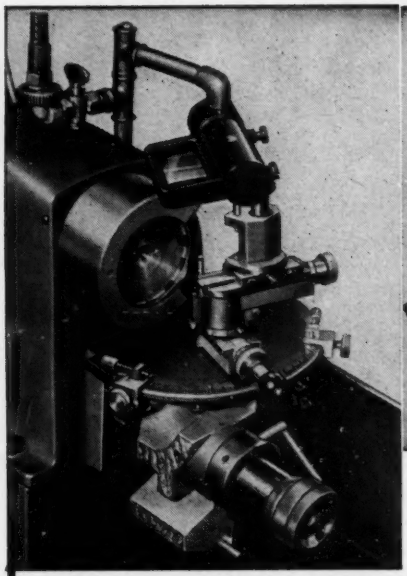

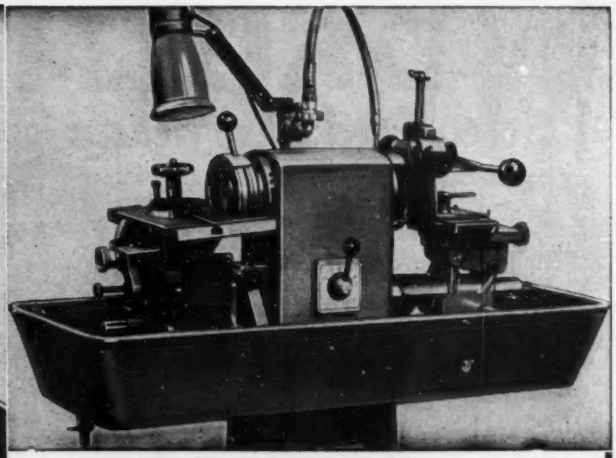

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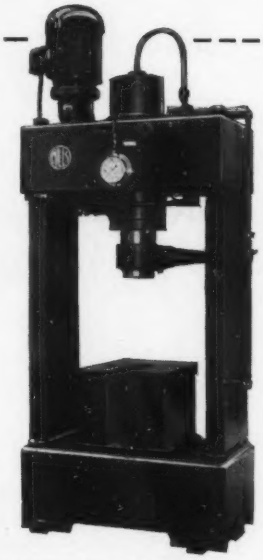

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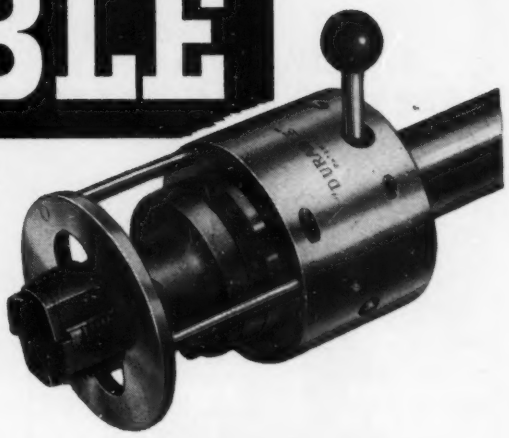

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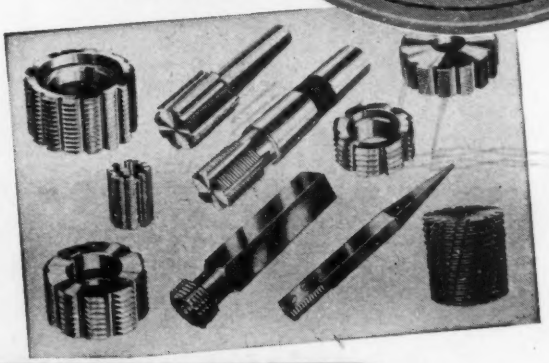

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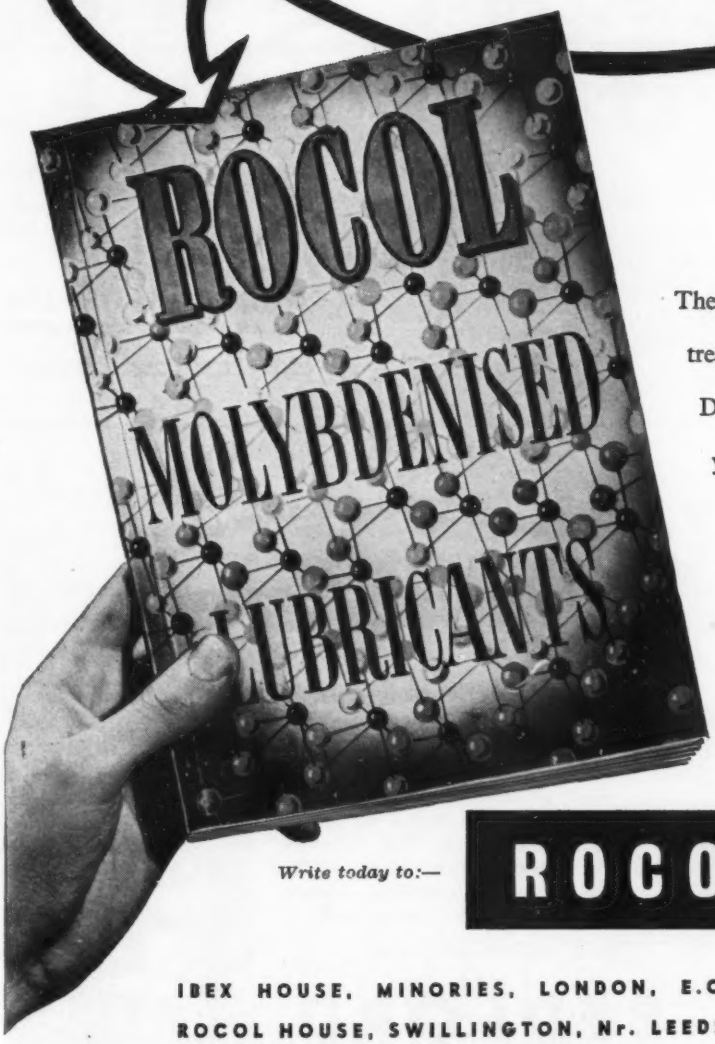

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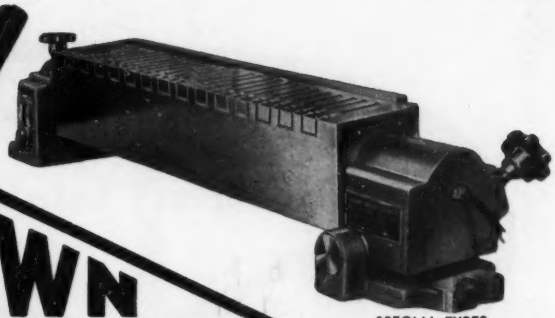

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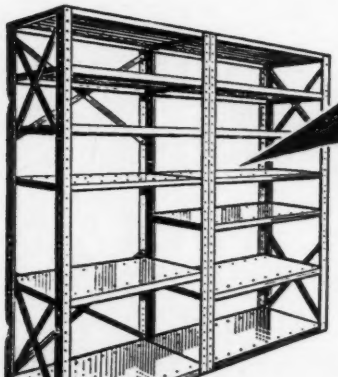

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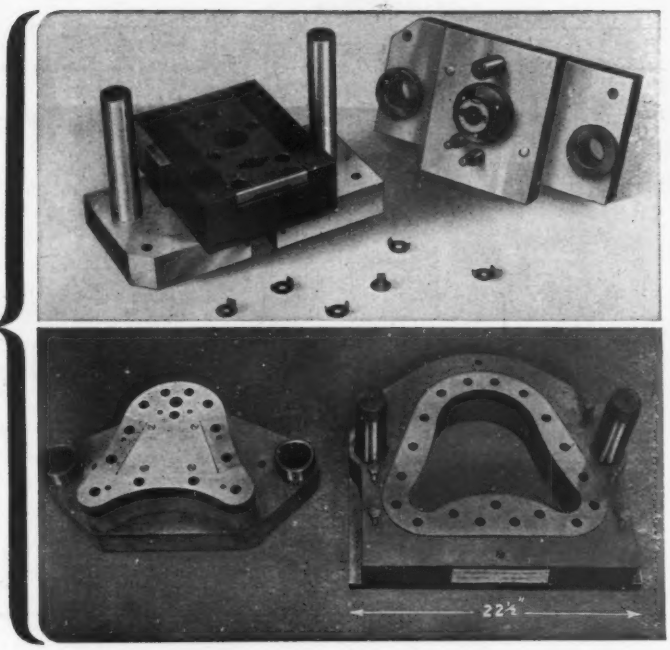

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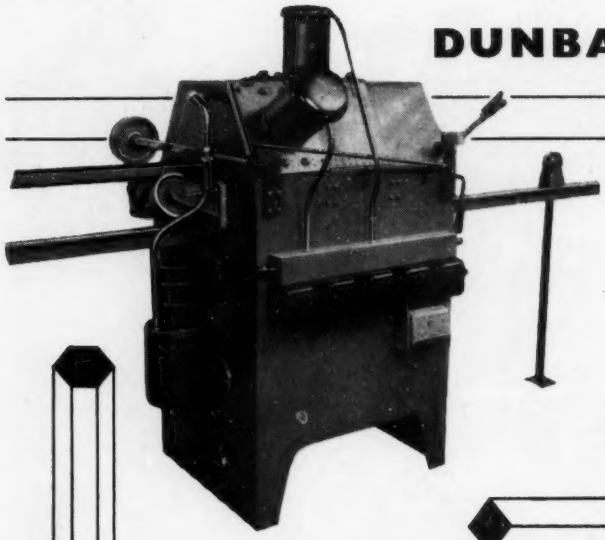

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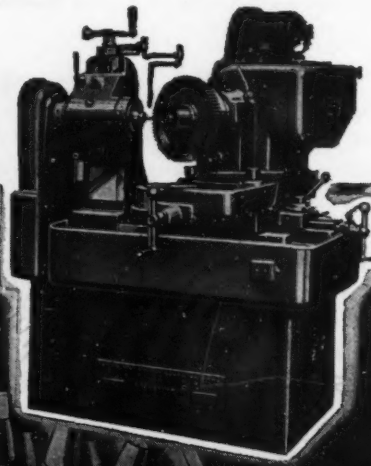

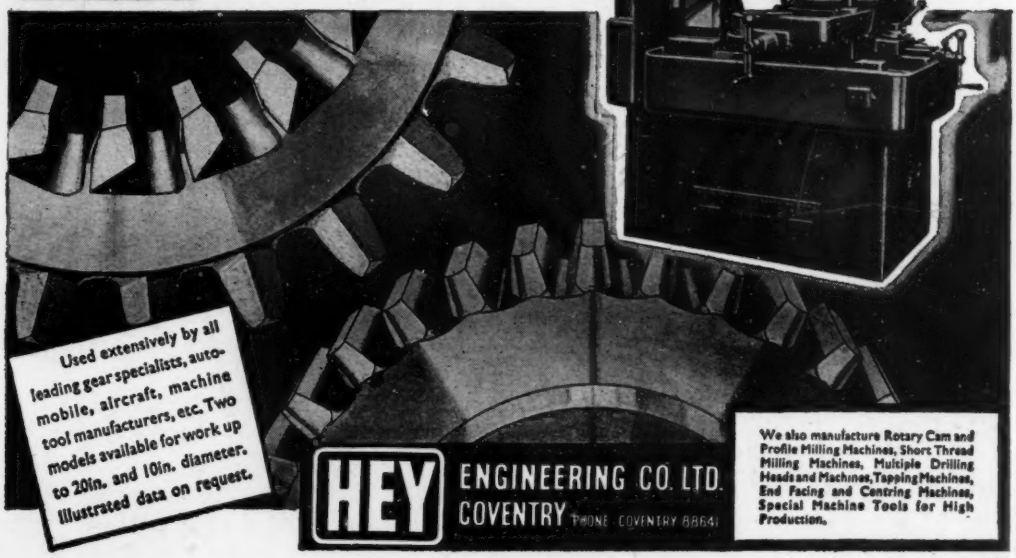

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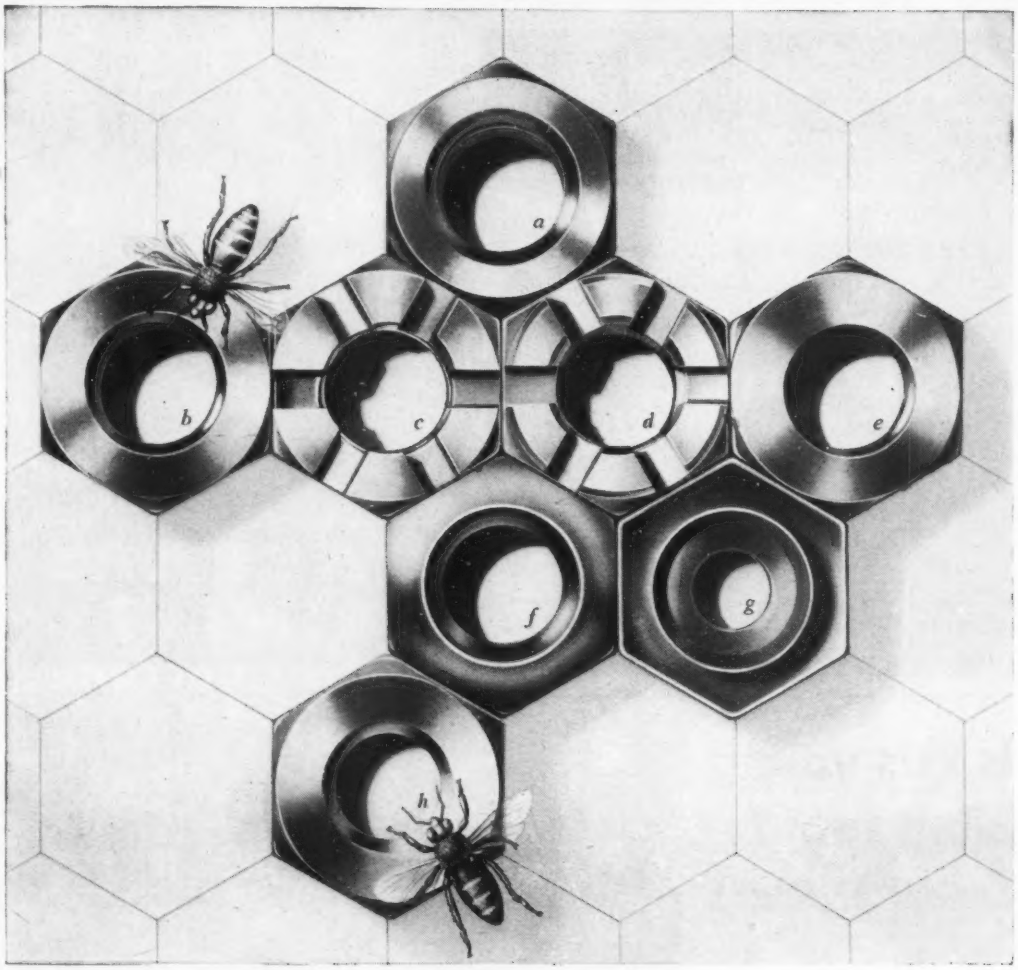

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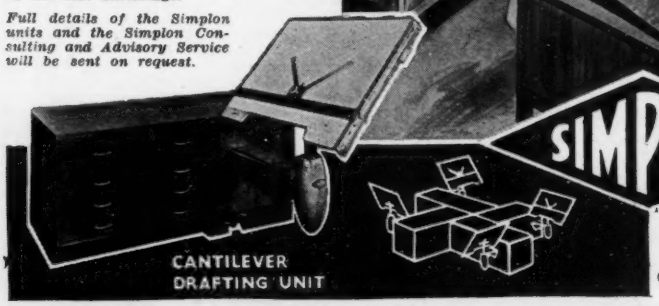

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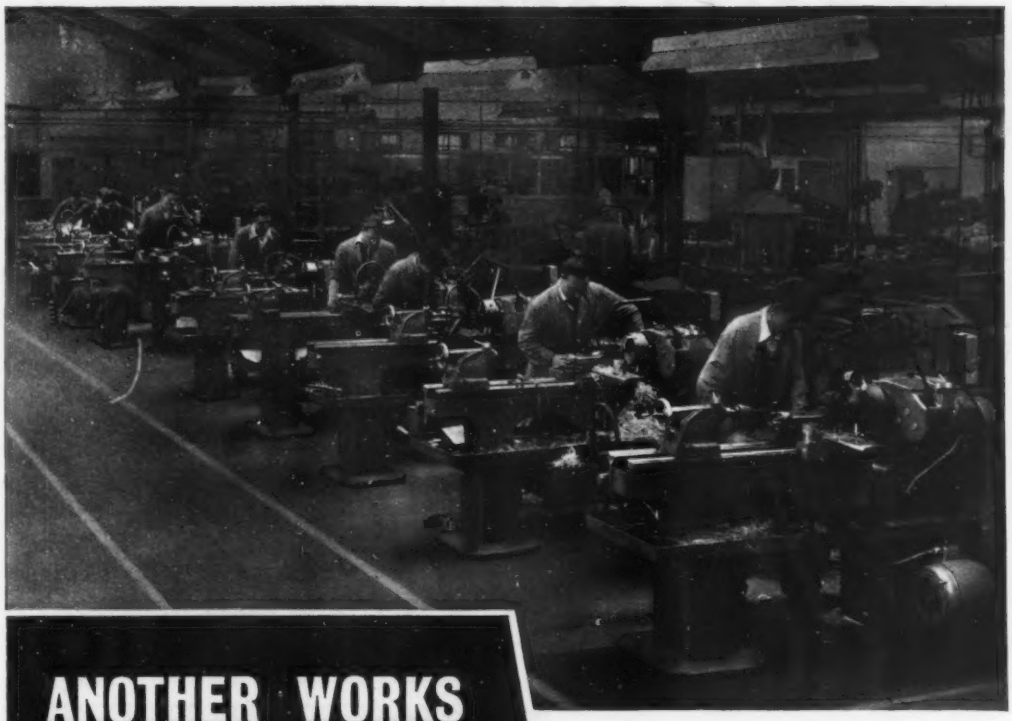

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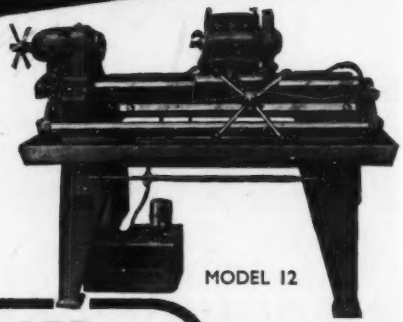

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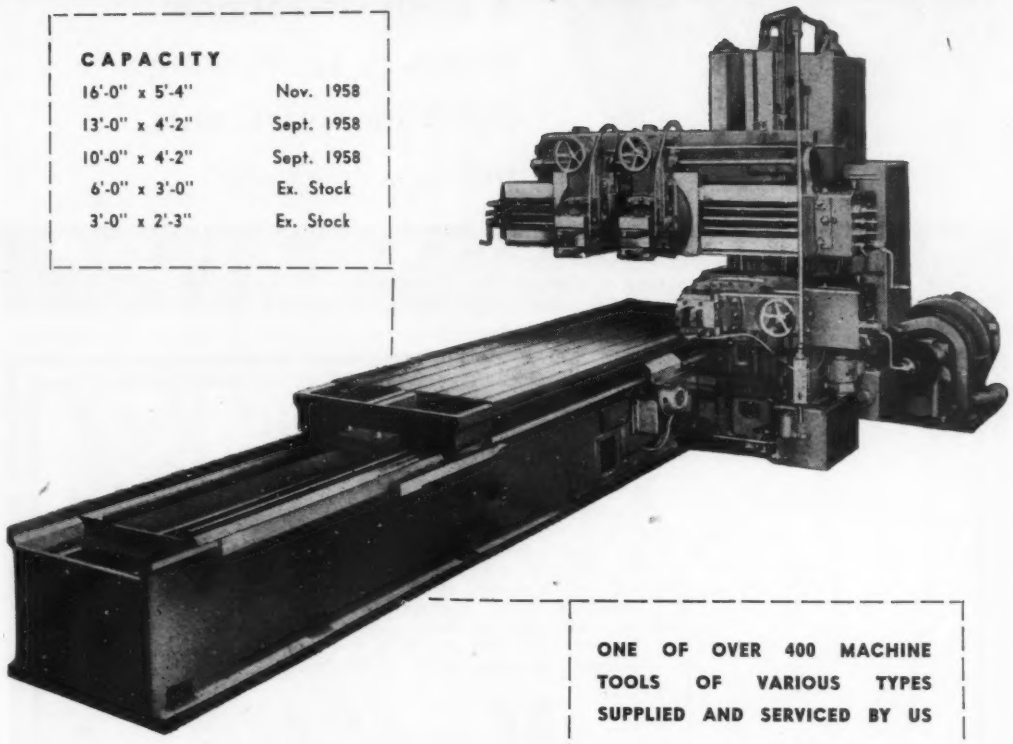

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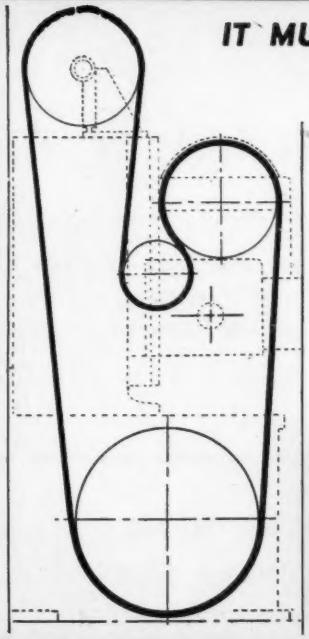

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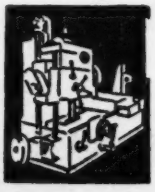

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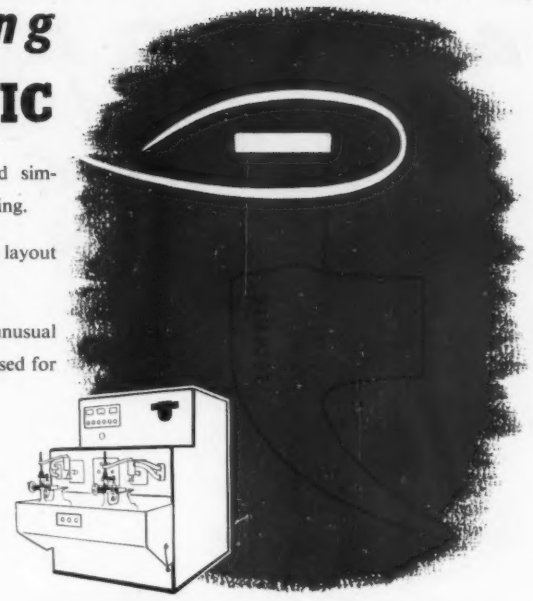

15 kW output installation used for hardening and tempering hammer heads. Illustration by courtesy of Lock Tools Ltd., Oldbury.

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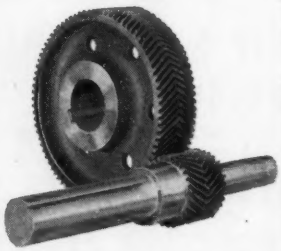

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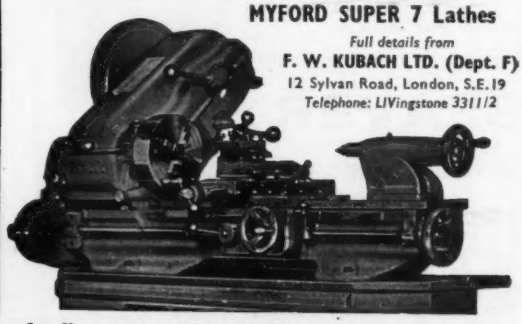

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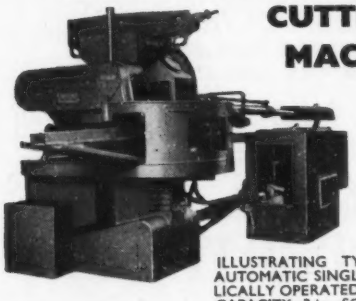

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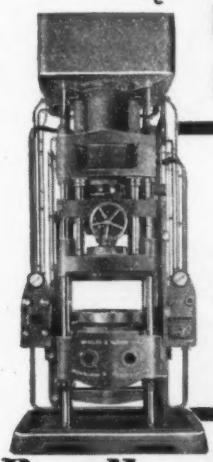

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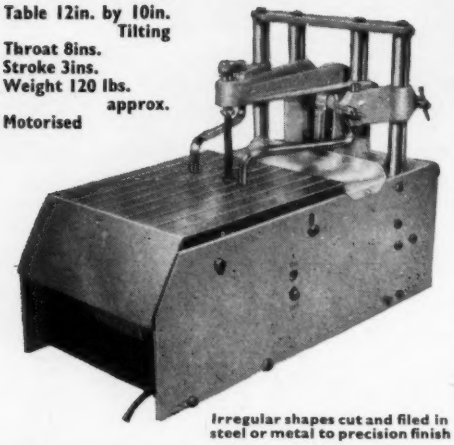

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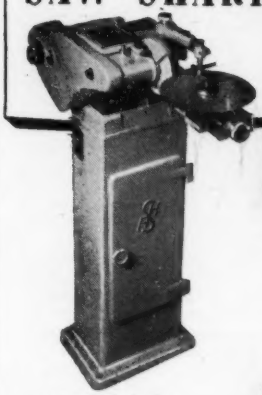

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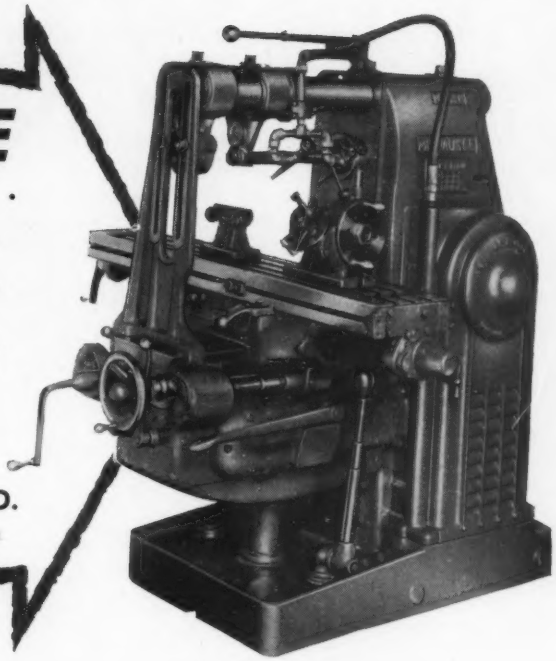

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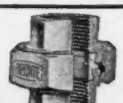

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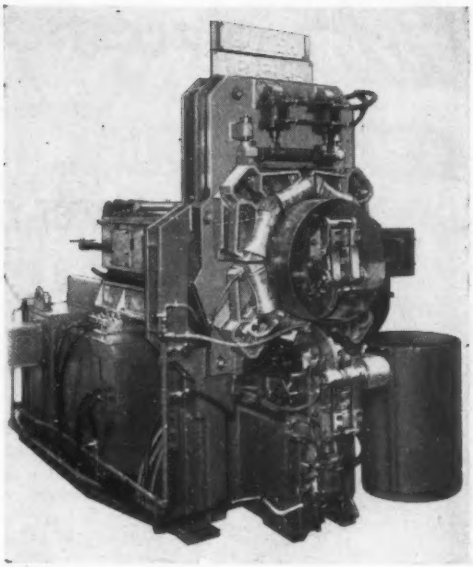

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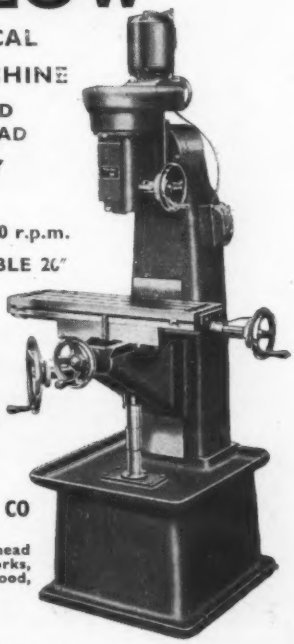

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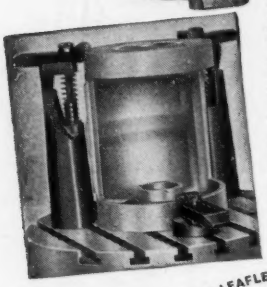

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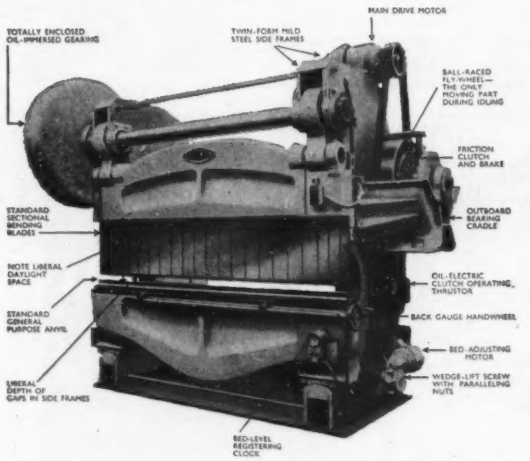
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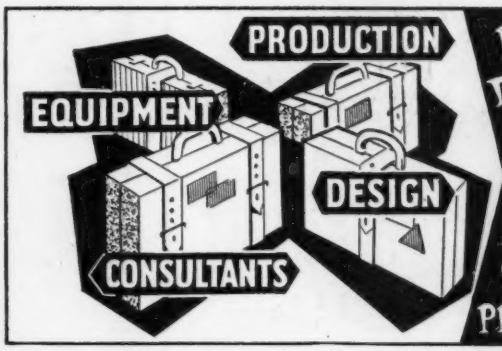

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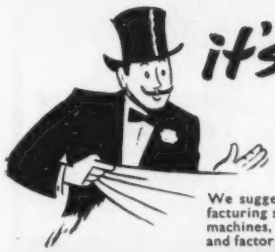

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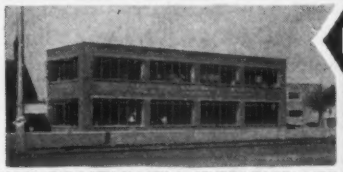

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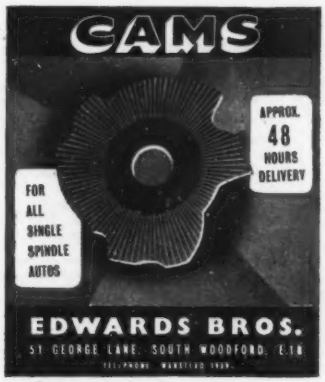

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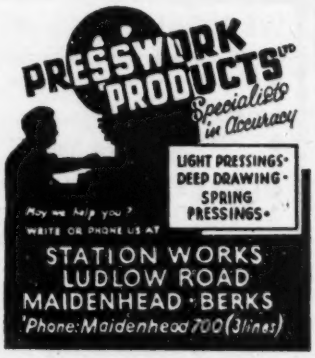
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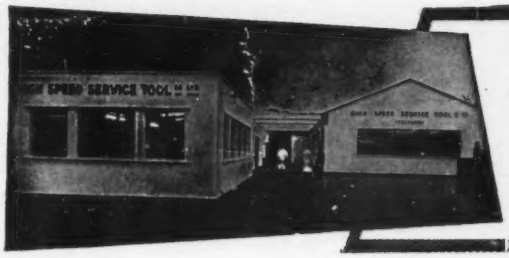

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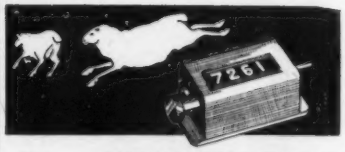

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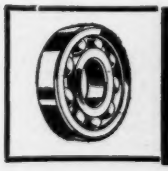

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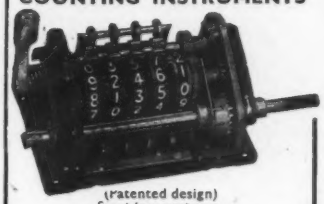

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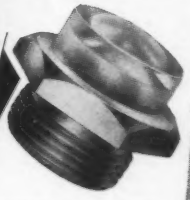

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The Proprietor of British Patent No. 787483 and U.S.A. Patent No. 2,821,817, for "Improvements in or Relating to Grinding Machines," would accept commercial exploitation by licence or otherwise. Prototype tested. Manufacturers who are interested are invited to write "W.Z." 8, Golborne Road, London, W.10.

The Proprietor of British Patent No. 707268 is prepared to sell the patent or to license British manufacturers to work thereunder. It relates to "Improvements in Turnover Devices for Moulding Machines."—Address: BOULT WADE & TENNANT, 112, Hatton Garden, London, E.C.1.

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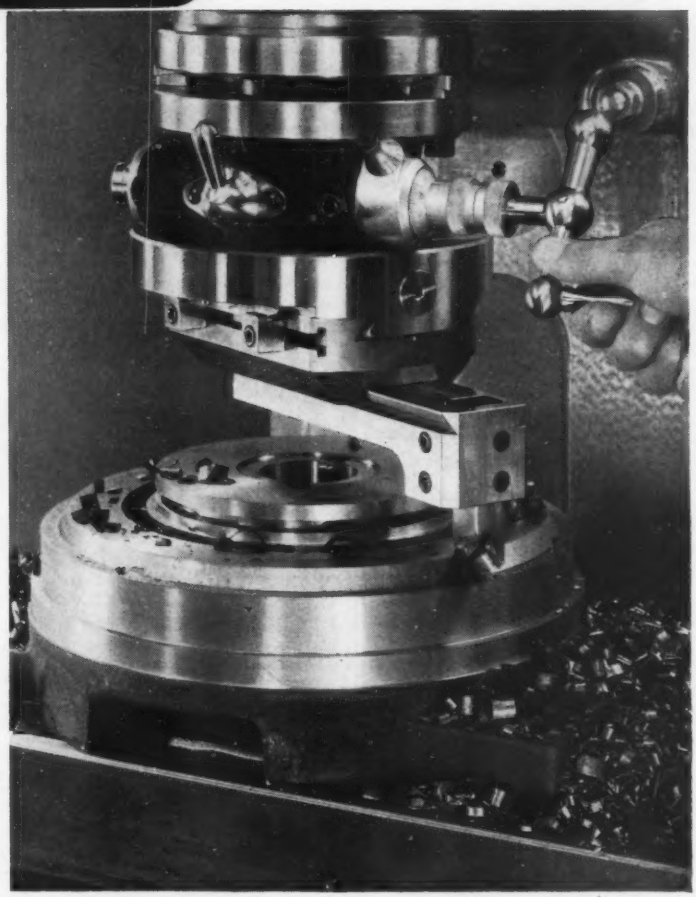

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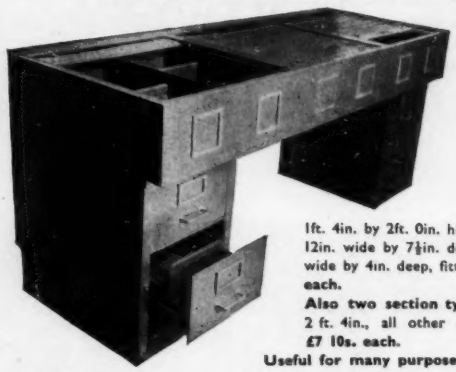

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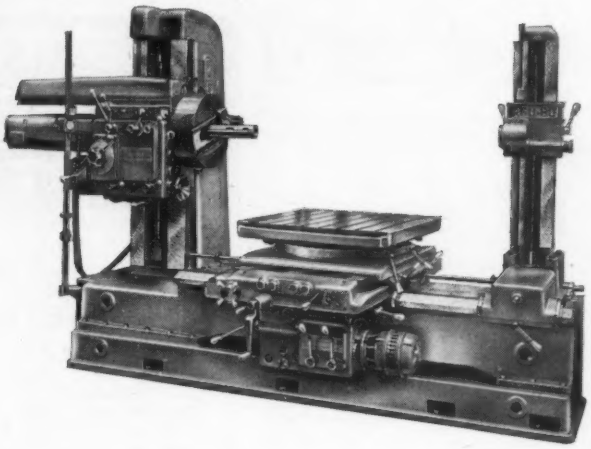

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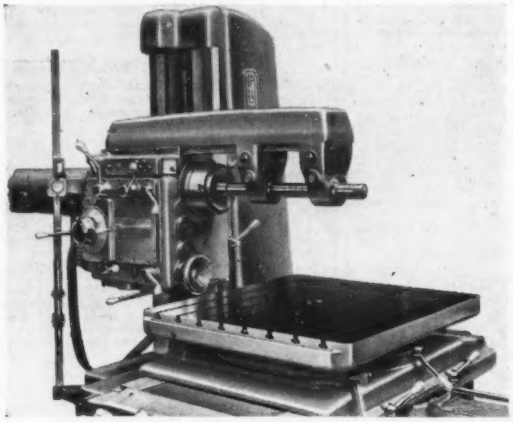

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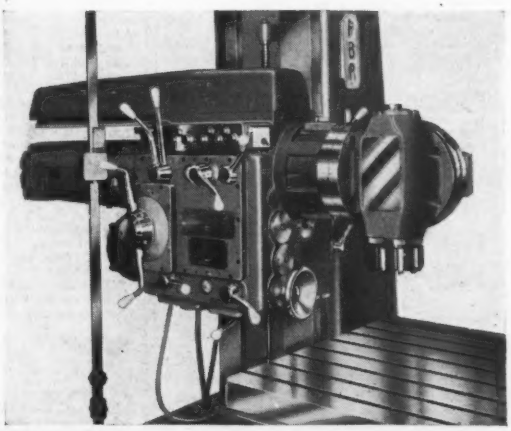

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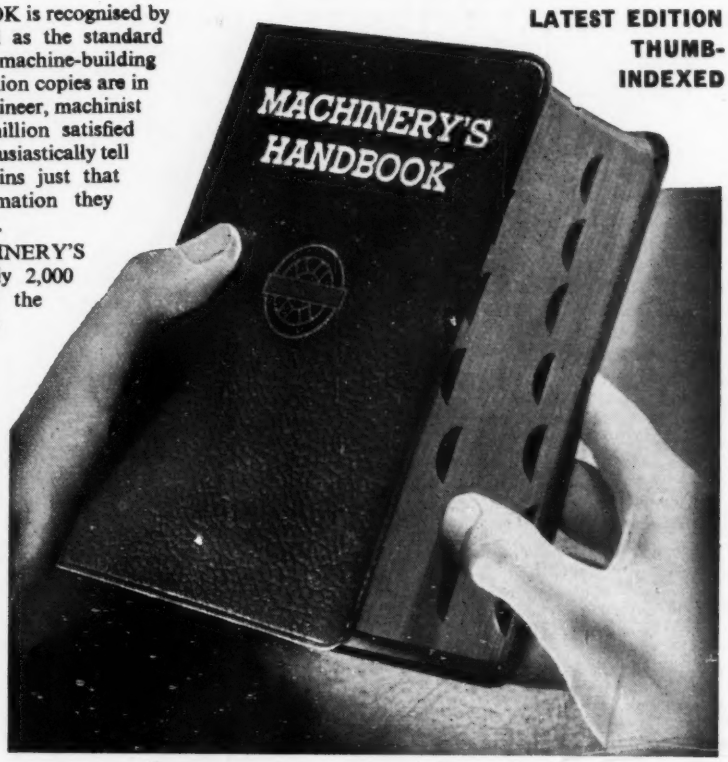

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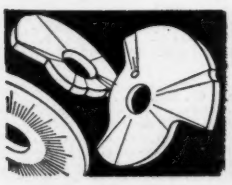

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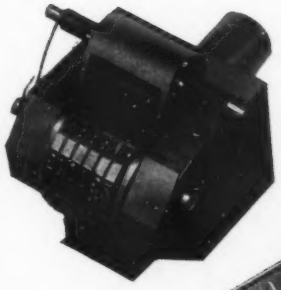

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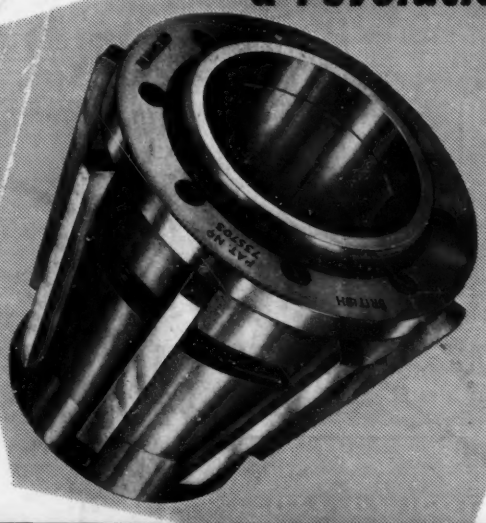

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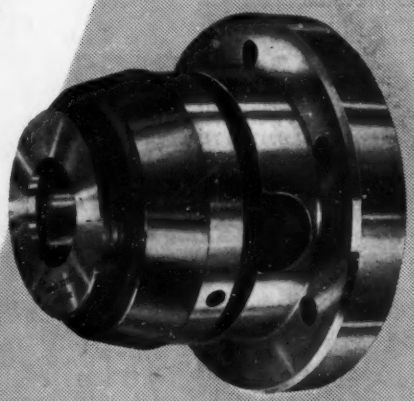

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